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(INCORPORATED).

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[WITH FRONTISPIECE, FORTY-TWO PLATES, AND FIFTEEN FIGURES IN THE TEXT.]

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THE Transactions OF The Royal Society of South Australia

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Vol. XLIII.

Obituary Notice.

WITH FRONTISPIECE.

It is with profound regret we refer to the death of one of our most eminent and helpful Fellows, the late Sir E. C. Stirling, Kt., C.M.G., F.R.S., M.A., M.D. (Cantab.), F.R.G.S., C.M.Z.S. He was elected a Fellow on October 4, 1881, a member of Council in 1882, and a Vice-President in 1883. Resigning this post in 1884, because he was leaving the State, he was re-elected in 1885 a member of Council, in 1888 Vice-President, and in 1889 he was chosen President. Directly his term of office expired he was again made a member of Council, and was repeatedly re-elected until 1900; so that he was in office for about eighteen consecutive years.

From the first he took an active and prominent part in the affairs of the Society; in fact, we find him in the chair within about four months of his election. Having been recently appointed Lecturer on Physiology at the University he showed and explained one of his laboratory instruments, Williams' Freezing Microtome; and being also a surgeon he exhibited some kangaroo tendon, and indicated its advantages as a ligature for tying vessels in operations.

He went to England in 1884 for a few months, partly to secure the most recent and perfect apparatus for conducting physiological observations, and these on his return he exhibited and described to the members.

In 1886 he showed a preparation of the genitalia of a female kangaroo, demonstrating the young attached by its umbilical cord, so proving it to be produced and born in the same manner as other mammals.

During 1889, the year of his Presidency, he was not once absent from the gatherings of the Society, and we find him

showing the cranium of a South Australian aboriginal presenting a marked resemblance to the celebrated prehistoric Neanderthal skull, and having a very ape-like appearance; also a specimen of teal of brilliant plumage *(Anas castanea)*. He did not know the locality from which it came, though several members had seen similar individuals in various parts of the Province. He did not agree with Gould that it was only the nuptial dress of the male of an ordinary teal, but felt satisfied it was a distinct species. On retiring from the Presidential chair he read an address on "Weissmann's Theory of Heredity," and the meeting carried a unanimous resolution that the address should be printed.

He was Chairman of the South Australian Museum Committee in the year 1884-5, and when Dr. Haacke resigned his position in 1889 Dr. Stirling was installed as Honorary Director of the Museum. This gave him free access to the valuable ethnological, palaeontological, and other novelties in that institution, many of which he brought before the Society as exhibits, or as subjects of the scientific papers with which he enriched our Transactions. There was, for instance, the marsupial mole *Notoryctes typhlops*, the blind burrower in the sand, first brought under our notice in 1888, and again named, described, and beautifully illustrated in 1891, and still further dealt with in the volume for 1894. In 1890 he accompanied Earl Kintore and a party overland from Port Darwin to Adelaide, and devoted himself to the collection of flora and fauna. In this way he was fortunate in securing half a dozen individuals of this new marsupial mole, as well as much other material, to supply not only our own Museum, but those in the Commonwealth and in foreign lands.

In 1893 he went with a party to Lake Callabonna to investigate the remarkable deposit of fossil bones belonging to gigantic extinct beasts and birds and to superintend their transport to Adelaide. By the patient industry and technical skill of Mr. A. E. H. Zietz they were collected, specially treated, packed, and removed to the Museum, where they were further prepared and preserved bone by bone; and from these Dr. Stirling and he were able to reconstruct the complete skeleton of the enormous marsupial, the *Diprotodon australis*, a cast of which graces the entrance-room of the Australian wing of the Museum. There were also parts of an immense wombat, the *Phascolomys gigas*, and portions of the skeleton of *Genyornis newtoni*, a struthious bird allied to the New Zealand moas, and almost equal in size to the largest of these. For more than four years these monsters occupied his attention, and several papers on the physical

features of Lake Callabonna and its fossil remains were submitted to our Society and were printed as Memoirs, of which they constitute the whole of our first volume.

In 1894 he accompanied the Horn Expedition to the MacDonnell Ranges as medical officer and anthropologist. To him was allotted the task of dealing with the ethnological material then collected, and in nearly 160 pages of the fourth volume of the Horn Scientific Expedition to Central Australia, 1896, may be found the results of his investigations. Doubtless we will remember his exhibition of quite a large number of ceremonial sticks and stones from that region, and the public lecture delivered under the auspices of our Society, in which he revealed the manners and customs of its inhabitants, illustrated with very fine diascopic photographs taken in Central Australia. He and Mr. Zietz dealt with all the vertebrata obtained by the Elder Exploration in 1893, and published their results in our Transactions for 1896.

In 1895 he was appointed Director of the Museum as a salaried officer, and held this post until the end of 1912, when he resigned (being followed by Mr. E. R. Waite), and in April, 1914, was made Honorary Curator of Ethnology. Sir Edward Stirling was, perhaps, as much interested in the anthropology and ethnology of Australia as in its palaeontology. He gradually accumulated a fine library of works dealing with its history and its aboriginals, and with the inhabitants of adjacent islands. He collected in our Museum a large series of native skulls and skeletons, implements of war and peace, and, in fact, everything pertaining to their primitive life, and he spent his last three or four years as honorary curator of this department in cataloguing, arranging, and displaying this exceedingly rich collection. The exhibit of these in the top gallery of the Australian wing of the Museum is a monument to his expert knowledge of this branch of science, as well as an enduring testimony to his persevering industry and special enthusiasm.

In 1898 he proposed a resolution in one of our meetings, which was carried unanimously, "That whereas the aborigines of South Australia are rapidly disappearing, it is desirable in the interests of science and of our successors that a comprehensive and enduring record of the Australian race in fullest anthropological and ethnological sense should be undertaken before it is too late." Whenever any paper dealing with this subject was presented for acceptance the Council felt it had in Dr. Stirling an expert to whom it could be submitted for an estimate of its value. It is to his zeal and patriotism that we possess a very large number of valuable and even unique examples of ceremonial ornaments and other

rarities which but for his intervention would have been lost, not only to our State, but to our nation.

As recently as 1911 he wrote a lengthy paper entitled "Preliminary Report on the Discovery of Native Remains at Swanport, River Murray, with an Enquiry into the Alleged Occurrence of a Pandemic among the Australian Aboriginals." He intended to discuss later his anthropological findings from examination of the bones and skulls of more than 160 natives obtained from the Swanport burial place, but "art is long, and life is short," and this work is left for some other hand.

He was also a lover of the Australian flora and fauna—an enthusiast in Natural History. The Field Naturalist Section found him ready to assist, as is witnessed by his evening lecture, in 1886, "On the Borderland of the Animal and Vegetable Kingdoms"; also in the appeals of its Flora and Fauna Protection Committee, made time and again to consecutive Governments of the day, for reservation of more or less of the western end of Kangaroo Island, under the name of Flinders Chase, as an asylum or sanctuary for our fast disappearing indigenous animals and plants. Dr. Stirling several times supported its petition by cogent arguments urged in its favour, rendered the more forcible by his well-known scientific standing.

As so recent and for so long a Fellow of the Royal Society of South Australia, we are in duty bound, as we are also glad, to pay a sincere and grateful tribute to his memory for the work he has done and the help he has given. Others than ourselves have during his lifetime been ready to recognize the value of his contributions. The Queen of the Netherlands conferred upon him a gold medal "for science and art" after the National Muesum of Natural History in Leyden, Holland, had been enriched by him. He was made a Fellow of the Royal Geographical Society and a Corresponding Member of the Zoological Society, and above all else, and valued by him beyond bronze or silver or gold decorations, was his title of "Fellow of the Royal Society of London." which stamped his published work with the hall-mark of excellence, and gave him an accredited place among the scientists of the world.

Jos. C. Verco, *President*.

Evening Meeting, April 10, 1919.

VITALITY OF SEEDS.

By ALF. G. EDQUIST.

[Read November 21, 1918.]

In March, 1918, were commenced a number of experiments for the purpose of finding a practicable way of safely storing grain for lengthy periods against the ravages of rats, mice, weevil, and rain. The object in our investigation was to determine, if possible, that *dry* grain (wheat) could be stored safely in an atmosphere rich in CO_2 or of nitrogen, from harvest to the time of seeding, and even for longer periods, without impairing its vitality or germinating qualities.

The report recently issued by Dr. Hargreaves, of the Chemistry Department, has necessitated the publishing of the following results. We had already been experimenting in this direction, and now have the pleasure of submitting further evidence of the value of the work done by the Department of Chemistry.

WHY CO_2 AND NITROGEN WERE CHOSEN.

1. It was recognized that CO_2 gas would quickly asphyxiate any animal life existing in the wheat, and prevent eggs of weevil and other beetles from hatching.

2. Carbonic acid gas is easily and cheaply generated.

3. It can be stored under pressure and safely transported to any part of the State.

4. It is perfectly safe and easily manipulated by any intelligent person.

5. It does not quickly destroy the vitality of *dry* wheat, and therefore might prove a safe medium in which to store seed wheat from harvest time to the time of seeding.

6. Carbonic acid gas is heavier than air, and readily displaces it.

Nitrogen was chosen because it fails to support life, is inert, and readily available without the use of gas-generating apparatus.

EXPERIMENT 1. — To prove whether or not dry grain respires.

Method.—A glass tube closed at one end was partly filled with *dry* wheat harvested in 1917. In the open end of this tube was sealed a straight piece of narrow glass tubing. A retort stand supported the apparatus with the open end of the

narrow tube immersed in fresh lime-water. Every day the tube containing the wheat was lifted from the lime-water and the contents aerated for a few minutes. The water film which sometimes closed the mouth of the narrow tube was removed with blotting paper, by centrifugal force or by the passage of an air current across the open end of the tube.

Result.—So far as visible evidence was concerned, dry wheat appeared to breathe very slowly or not at all. The grain appeared to be in a state of suspended animation. From the results of other experiments on vitality of seeds, it is definitely known that each kind of seed retains its vitality for a more or less lengthy period, and then dies either from the effects of desiccation or oxidation of the germ plasm. It may be said that a seed stored in a dry condition either dies of thirst or breathes its life away. Some seeds that we have tested lose their vitality at the end of one or two years; others, such as acacia seeds, retain their germinating qualities for years. The seeds of *Goodia latifolia* are credited with having retained vitality for 105 years. Ten years ago Professor A. J. Ewart, of Melbourne, gave me three seeds of *Goodia latifolia* which he said were 101 years old. One of the three was successfully germinated.

EXPERIMENT 2.—To demonstrate that germinating grain respires freely.

Method.—The apparatus was arranged and manipulated in every particular as in Experiment 1, the only difference being the condition of the enclosed grain. The wheat used was placed in water at a temperature of 160° Fah. and allowed to cool, and to soak for twenty-four hours, before being enclosed in the glass tube. This treatment caused the grain to germinate rapidly, and probably helped to minimise attacks from moulds.

Result.—The lower end of the narrow glass tubing, which extended below the surface of the lime-water, and into which the lime-water was forced by atmospheric pressure as the oxygen was converted by the wheat into CO_2 gas, became clogged with a white deposit of carbonate of lime. The significance of this result may be stated thus:—The oxygen of the air enclosed with the wheat was slowly absorbed by the germinating grain and converted into CO_2 gas. As fast as the CO_2 was formed it gravitated towards the lime-water and was absorbed with the formation of carbonate of lime.

The inference.—Germinating wheat breathes freely and requires oxygen.

EXPERIMENT 3.—To prove that dry grain can be stored in an air-tight receptacle for a considerable period without impairing the vitality or germinating qualities of the grain.

Method.—On March 1, 1918, small quantities of wheat harvested in 1917 were sealed in three glass bottles—A, B, and C, respectively.

Test (1).—At the end of fourteen days the wheat in bottle A was planted on damp soil under a sheet of glass.

Result.—The grain germinated freely.

Test (2).—At the expiration of twenty-eight days the wheat in bottle B was planted on damp soil under glass.

Result.—The grain grew freely.

Test (3).—On September 13, just 196 days after being sealed in bottle C, the grain was planted on damp soil under glass.

Result.—The grain grew freely.

Conclusion.—The result of these three trials, which mark progress in a long series of experiments, goes to show that wheat may be stored in hermetically sealed receptacles for a considerable period without impairing its vitality.

EXPERIMENT 4.—To prove that *dry* grain can be safely stored in an atmosphere rich in CO_2 gas for considerable periods without injury to the vitality of the seed.

Method.—Small quantities of grain harvested in 1917 and having good germinating qualities were placed in three bottles—A, B, and C, respectively. The bottles were charged with CO_2 gas and then sealed. The method of charging the bottles was simple. CO_2 gas, generated in a flask from marble and hydrochloric acid, was introduced by means of a delivery tube passing through the stopper of the bottle. The displaced air passed through a second tube into lime-water. The lime-water was used to test the quality of the air expelled from the bottle containing the grain. When the overflow was rich in CO_2 the bottle was carefully sealed.

Test.—At the end of fourteen days, twenty-eight days, and 196 days, respectively, the grain in the three bottles was tested by planting it on damp earth under glass.

Result, Bottle A.—After immersion for fourten days in air rich in CO_2 gas the grain grew well. It appeared to show more vigour than the untreated grain used in the check experiments.

Result, Bottle B.—The grain grew well after experiencing the effects of CO_2 gas for twenty-eight days.

Result, Bottle C.—At the end of twenty-eight weeks the grain appeared not to have suffered as a result of confinement in air rich in CO_2. The grain germinated freely.

Note.—It will be noticed that the results of germination have not been expressed in percentages. To secure accurate

percentage results it would be necessary to duplicate the experiments to an extent impracticable under the circumstances governing work in the laboratory where 225 students are conducting two or three experiments each.

EXPERIMENT 5.—To demonstrate that *dry* wheat may be stored for some time in an atmosphere of nitrogen gas without impairing the vitality of the seed.

Method.—Small quantities of wheat harvested in 1917 were placed in three bottles—A, B, and C, respectively. In each bottle were placed two small tubes, one containing lime-water and the other an aqueous solution of pyrogallic acid. The bottles were then carefully sealed. The lime-water absorbed the CO_2, the evidence being the formation of a crust of carbonate of lime within the tube containing the lime-water. The aqueous solution of pyrogallic acid absorbed the oxygen contained in the bottle, evidence of the absorption being the brown discolouration of the otherwise perfectly clear liquid.

Test (1).—The grain from bottle A grew well when planted on damp soil under glass. Immersion in practically pure nitrogen for fourteen days did not seem to produce any bad effects.

Test (2).—At the end of twenty-eight days the grain from bottle B was planted on damp soil under glass. It germinated freely.

Test (3).—Through an accident the bottle was broken and the grain lost before its vitality could be tested. A later experiment demonstrated that *dry* wheat enclosed in an atmosphere of nearly pure nitrogen can retain its vitality for a period of 104 days, but will not survive an immersion in nitrogen for more than 143 days.

EXPERIMENT 6.—To demonstrate the behaviour of *wet* grain stored in an air-tight receptacle.

Method.—A small quantity of wheat harvested in 1917 was soaked in water for about twelve hours. It was then drained of free water, and sealed in a bottle having a few layers of wet blotting-paper at the bottom.

Result.—The grain germinated and grew freely until the plumule became about five-eighths of an inch long and the radicle carrying root-hairs had grown to a length of three-quarters of an inch. At this stage of growth further development ceased. No chlorophyll was developed in the plumules, although they were exposed to light. The plants quickly perished.

EXPERIMENT 7.—To demonstrate the visible effects of CO_2 on *wet* wheat enclosed in an air-tight receptacle.

Method.—A small quantity of wheat that had been soaked in water for about twelve hours was sealed in a bottle containing CO_2 gas. The method of charging the bottle with CO_2 was the same as that employed in Experiment 4.

Result.—The grain failed to germinate, but swelled to an unusual size before it died.

Inference.—Germinating wheat is asphyxiated by CO_2 because of the absence of chlorophyll in the plumule.

Experiment 8.—To demonstrate the effects of an atmosphere of nitrogen upon *wet* wheat.

Method.—The apparatus and methods employed were similar to those outlined in Experiment 5. In this instance soaked wheat was used instead of dry grain.

Result.—Germination proceeded slightly, just sufficient to show the development of the radicle and plumule. Growth ceased abruptly and the grain died. No chlorophyll was formed in the plumule.

Inference.—Free oxygen is essential to the development of a germinating seed, and also to the development of chlorophyll.

Simple Method of Testing Air-tight Bottles.

Completely immerse the sealed bottle in water that is a little warmer than the atmosphere. The air within the bottle expands, and should the bottle leak, silvery-looking air-bubbles will mark the position of the aperture.

Concluding Remarks.

1. Vermin may be destroyed in properly-enclosed wheat stacks by the use of CO_2 or nitrogen gas without damage to the germinating qualities of the grain.

2. Perfectly ripe, dry grain can be safely stored from harvest time until the time for seeding in an atmosphere rich in CO_2 gas.

3. Excess of CO_2 gas and nitrogen prevents the development of weevil from eggs within a properly-heated stack.

4. Any ordinary barn properly lined with asbestos sheets will serve as a suitable storehouse or gas-envelope.

5. The CO_2 gas can be generated by pouring dilute hydrochloric acid on chips of marble or limestone.

6. The gas should be introduced near the top at one end of the stack, and the outlet pipe for the displaced air should be inserted near the bottom of the stack at the other end.

7. The escaping air should be tested with a little lime-water. When the escaping air causes the lime-water to turn

milky in appearance, sufficient CO_2 for all practical purposes has been introduced.

8. If the inlet and outlet pipes be fitted with stopcocks, the CO_2 gas can be drawn off at any time to permit of entrance to the barn. If both stopcocks be opened the CO_2 gas will drain away through the lower tap.

9. Asbestos-covering to stacks built on stone or concrete floors is suggested, because it is fire-proof, rat and mice-proof, and will withstand heavy knocks which would make holes through softer material. When the asbestos-coverings to stacks have served their purpose, the material could be sold or used for building purposes. Less durable materials are more costly in the long run.

10. Cracks and joints can be made gas-tight with a stiff mixture of finely-ground pipeclay and raw linseed oil.

11. Asbestos sheets can be made in the State from local deposits of the mineral.

Australian Fungi: Notes and Descriptions. No. 2.—The Sclerotia-forming Polypores of Australia.

By J. Burton Cleland, M.D., and Edwin Cheel, Botanical Assistant, Botanic Gardens, Sydney.

[Read April 10, 1919.]

Plates I. to V.

In Australia there seem to be at least three species of stipitate polypores growing from large true sclerotia, and two from large false sclerotia. Of those with true sclerotia, the best known is *Polyporus mylittae*, the "Native Bread." It is characterized by a very large sclerotium, which on section is divided up into alveolar spaces, whilst the fruiting body has a whitish pileus with a centre the colour of a poached egg. The sclerotium of the second species resembles closely that of the former, but is smaller, whilst the pileus is brown. C. G. Lloyd (Mycolog. Notes, No. 39, December, 1915, p. 533, figs. 728-732) has described specimens of this species received from one of us as *Polyporus mylittae*, but we have compared our other examples of it with fruiting bodies obtained from R. T. Baker, described by him (Proc. Linn. Soc. N.S. Wales, vol. xxvii., p. 542, 1902) and deposited in the Technological Museum, Sydney, and the two are apparently distinct species. The sclerotium of the third form is also very large (one weighed 7 lbs.), and resembles the other two, though the exterior differs, and the cut surface does not show any alveolar arrangement. So far we have not obtained fruiting bodies of this.

The forms with false sclerotia have a deeply-situated mycelium which penetrates and surrounds sand and small stones, compacting them together into a mass, at times enormous. One of these is *Laccocephalum basilapiloides*, the "stone-making fungus," and the other is the fruiting body belonging to the mycelial masses referred to by Lloyd when speaking of *Polyporus tumulosus* (Synop. of Sect. Ovinus of Polyp., p. 87).

We have had an opportunity of examining the type of the former in the Herbarium of the University of Adelaide, and find it is closely allied to, but apparently not identical with, a specimen we recently collected that seems to be the

latter species. We find from an examination that *L. basilapiloides* does not belong to the section Amaurodermus, as Lloyd, from its description, was led to believe, but probably to the section Ovinus.

Acknowledgments.

We wish to express our indebtedness to the following for their courtesy in affording us facilities for examination of the specimens contained in the collections under their care:—

To Mr. J. H. Maiden, I.S.O., F.R.S., of the National Herbarium, Sydney.

To Mr. R. T. Baker, of the Technological Museum, Sydney.

To Professor Sir W. B. Spencer, C.M.G., F.R.S., of the National Museum, Melbourne.

To Messrs. W. Laidlaw, Biologist, and C. C. Brittlebank, Plant Pathologist, of the Department of Agriculture, Science Branch, Melbourne.

To the Board of Governors of the Public Library, Museum, and Art Gallery of South Australia; and to Mr. Edgar R. Waite, Curator of the South Australian Museum.

To Professor T. G. B. Osborn, of the University of Adelaide.

To Mr. A. G. Hamilton, for the photographs in pl. v., figs. 1 and 2.

Polypores with True Sclerotia.

81. *Polyporus mylittae*, Cooke and Massee: Grevillea, vol. xxi., p. 37 (1892).

The subterranean sclerotium, or "tuber," called "Blackfellow's Bread," "Native Bread," or occasionally "Native Truffle," was originally described under the name *Mylitta australis* by Berkeley in 1839. It is also recorded in M. C. Cooke's Handb. of Austr. Fungi, No. 1351, under the latter name. In 1885 H. T. Tisdall discovered some specimens with fructification, and forwarded them to M. C. Cooke, who identified them as a *Polyporus* and named them *P. mylittae* (Gardener's Chronicle, Oct. 29, p. 526, 1892). In 1902 R. T. Baker (Proc. Linn. Soc. N.S. Wales, vol. xxvii., p. 542, pls. xxii. and xxiii. [1902]) exhibited some specimens with sporophores, and gave a detailed description of the same, and also had a coloured drawing made of the fresh specimen, which shows that the pileus is quite velvety and whitish, with more or less egg-yellow on the upper-surface. By his kind permission we are able to reproduce part of his sketch of the

fresh specimen. D. McAlpine, Government Vegetable Pathologist of Victoria, in 1893 (The Australian Journal of Pharmacy, Melbourne, viii., p. 291, Sept. 20 [1893], and Journ. Agric., Vict., ii., p. 1012 [figs. i.-v.], 1903), gives a very interesting and complete account of this species, together with photographic figures showing various stages of development. Professor A. J. Ewart (Proc. Roy. Soc. Vict., vol. 24, N.S., p. 59 [1911]), gives an account of some experiments in which he induced some sporophores to develop which measured 5 in. across. As showing the size to which these sclerotia may attain, we may mention that W. H. Breton (Tas. J., ii., p. 463, 1846) refers to a specimen of "Blackfellow's Bread" weighing 25¼ lb. J. H. Maiden (Agric. Gaz., N.S. Wales, iv., p. 909, 1893) states that A. P. Miller, of Hobart, had sent a specimen weighing 39 lb., and that a sclerotium obtained at Bundanoon, in New South Wales, measured 24¼ in. in circumference and weighed 5 lb. 14¾ oz. when fresh. He also mentions another Tasmanian specimen weighing 14 lb. (Tas. Cat., Exhib., 1851).

In the National Herbarium, Sydney, there are quite a number of sclerotia which we believe belong to this species, but so far no sporophores have been forwarded with them. The localities from which these have been received are as follows:—

New South Wales—Wolumba (P. J. O. Poole, November, 1899); Garra, Great Western Railway (J. H. Maiden, 1899); Box Point, Barber's Creek (J. H. Maiden, October, 1905); Burragong (C. Miller, April, 1905); Robertson (P. Williams, May, 1909); Eastwood (C. Lund, July, 1910); Wallangarra (F. Jaeger, September, 1912); Epping (J. Cole, January, 1915); Sassafras, *via* Nowra (R. C. Sturgis, December, 1915); Inverell (T. McDonough, March, 1916). Victoria—*Ex Kryptogamae exsiccatae* (No. 211), Vienna, section only; Upper Ferntree Gully (J. M. Griffiths, March, 1909). Tasmania—Haweah, Bellerive (Miss Murphy, July, 1901).

The following are in the Technological Museum, Sydney:—(1) Sporophore (pl. i.), now quite velvety on pileus and stem, whitish. Pores dirty brownish-white. Sclerotium about 6 in. × 4 in. Its outer-surface irregularly bossed and folded with large brownish flakey crusts weathering to expose a light-brownish, almost white, surface. Cut surface alveolar, walls of alveoli white, polygonal area about 5 mm. in diameter, waxy-yellow.

(2) Another sclerotium is wrinkled with an earthy-brown cuticle, which is thin and peeling off.

The following specimens are in the South Australian Museum, in the portion set apart for exhibiting the foods of the aboriginals:—

(3) Sclerotium when fresh probably about 9 × 6 × 3 in. After arrival at the Museum it began to develop a sporophore. The upper-surface of this abortive fructification is pitted, from the specimen having been lying on perforated zinc. The surface is now dull white with slight brownish stains and finely villous. The pileus is very distorted. Irregular whitish pores have formed. Spores were not seen. Unearthed at the cyanide works of the Tasmanian Tailings Syndicate, Middle Arm Channel, River Tamar, Tasmania. Presented by Mr. Clement Phillipson, 1906 (Mus., No. 182).

(4) An irregular sclerotium, 3 × 4 in. G. F. Thorp, 1899 (Mus., No. 183).

(5) Sclerotium, 4 × 3 × 2 in. Found at Myponga "about 2 ft. underground near a gum tree in wet and sandy soil, 27/7/04. *Advertiser* Office (*vide* Proc. Roy. Soc. S. Aust.)" (Mus., No. 181).

(6) A small distorted sclerotium, 4 in. long. Professor Tate, Victoria (Mus., No. 184).

The following is in the Herbarium of the University of Adelaide:—

(7) Sclerotium apparently about 6 in. across when fresh. About 10 in. below the surface in mallee limestone country, Denial Bay district, South Australia. Presented by Mr. J. W. S. Mann, Saddleworth, South Australia, 15/10/12.

The following are in the Melbourne National Museum:—

(8) A large specimen from Toongabbie.

(9) A specimen from the Pride of Stranger's Mine, Yackindal.

Dr. F. Stoward has found the sclerotium of this species in Western Australia. By his kind permission, we are able to reproduce his excellent photographs of this (pl. ii.).

82. *Polyporus minor-mylittae* (? *Mylitta australis minor*, Berk., in Jour. Linn. Soc. (Bot.), vol. xiii., p. 175 [1873]).

We adopt this name for what we regard as a distinct species, which may be distinguished by the smaller sclerotium and a different coloured sporophore. It has already been recorded by one of us in Proc. Linn. Soc. N.S. Wales, vol. xxxviii., p. 170 (1913), and also by C. G. Lloyd in Letter No. 58, pp. 2 and 5 (1915), Note 269; and Mycol. Notes, No. 39, p. 533 (1915).

"Pileus (pl. iii.) 3-7 cm. across with a sulcate, minutely tomentose surface, raw umber (brown). Flesh usually dry,

subligneous, usually in two layers, each 1 to 3 mm. thick, the upper rich cream to light brown, the lower white. Stipe mesopodial, 5-15 mm. thick, 2-6 cm. long. Pores small, roundish or irregular, 2 to 3 mm. long. Spores abundant, cylindrical, 2×6 μ, hyaline, smooth."—Lloyd. We have a fine series of specimens in various stages of development, some showing the sclerotia in the making from less than the size of peas, while other sclerotia are fully developed, varying in size from 2 to 7 cm. in diameter. Some specimens dug up out of the ground at Hill Top in February, 1913, show the formation of several minute sclerotia varying in size from 2×4 mm. to 6×9 mm., attached by whitish rhizomorphs to decaying *Eucalyptus* stumps. The series of specimens show that the spores germinate in moist soil, and that the hyphal strands absorb nutrient matter from decaying stumps, ultimately forming the sclerotia. In other specimens the sclerotia are soft and spongy, and are being exhausted for the purpose of forming the sporophore, as the surrounding soil is traversed by a mass of branching mycelial cords forming an indefinite mesopodial stem surmounted by the cap.

Sporophores, in various stages of development attached to mycelial cords arising from the sclerotia, have been examined from the following localities in New South Wales:—Killara and North Sydney (H. Selkirk, May, 1904, and November, 1905); Hill Top, Main Southern Line (E. C., April, 1912; February, 1913; March, 1914; and February, 1916). There are also specimens of sporophores in the National Herbarium, Sydney, unattached to their sclerotia, from the following localities:—Barber's Creek (J. H. Maiden, December, 1897); Wahroonga (W. Buckingham, July, 1899); Leura (A. A. Hamilton, March, 1910); Glenorie (E. C., February, 1910); Lawson (Miss D. Wiles, communicated by Mr. A. G. Hamilton in June, 1910). Specimens of sclerotia without sporophores are from the following localities:—Bibbenluke (Miss E. Edwards, August, 1899); Bega (Miss M. R. Otton, May, 1905); Hurstville (H. W. Hamilton, June, 1910); Hornsby (P. Williams, April, 1916).

Other Sclerotia.

In addition to the above we have also examined several remarkable sclerotia, but so far their fruiting bodies have not been found. They consist of:—

83. Two very large sclerotia (pl. iii.), somewhat resembling those of *P. mylittae*, found by Mr. W. R. Griffin, of Hurstville, Sydney, in the western suburbs of

Sydney, in the early autumn. The largest of these was roughly spherical, 6 × 5 in., and weighed 6 lb. 12 oz. The outer-surface was of a reddish-clay colour, irregularly furrowed and finely reticulated. On section there was an outer hard reddish crust, ¼ in. thick in places. Inside this the sclerotium consisted of a greyish mycelial mass showing irregular whitish strands in places. Attempts were made to get the sporophores to develop, but a whitish mould-like growth alone appeared.

84. Sclerotia like worm-castings. Specimens of these are in the Botanical Department at the University of Adelaide from W. H. Jackson, Robe, South Australia, September, 1912, and A. Trezize, Robe; and others in the South Australian Museum from Lake Albert (Mus., No. 186). These sclerotia are clay-brown in colour, up to 3 in. long and ½ in. thick, or 2 × 1 in., and are irregularly ringed and rugose, very closely resembling earthworm casts. The constrictions sometimes cut deeply in, so as to leave adjacent portions attached by a quite narrow neck. The substance is hard, dense, and somewhat translucent white.

85. Irregularly round sclerotia, perhaps forms of No. 84. In the Herbarium of the University of Adelaide from S. H. McMillan, Chemist, Mount Gambier, September, 1912. ⅝ in. in diameter, somewhat flattened spheroid in shape; slightly rugose, clay coloured, weathering to show a greyish surface. On section hard, the colour of semi-translucent quartz.

86. In the South Australian Museum, in the section devoted to the food of aboriginals, with a label, "Fungus grown on the ground. Eaten by the blacks, Central Australia. Presented by Mr. E. J. Warman" (Mus., No. 185). This sclerotium appears different from any of the others we have seen, but is considerably decayed. It is a somewhat pear-shaped light mycelial mass, splitting and irregularly alveolate, apparently composed of mycelium and reddish sand.

Polypores with False Sclerotia.

87. *Polyporus tumulosus*, Cooke: Grevillea, xvii., p. 55 (1899); Handb. Austr. Fungi, No. 586; Baker: Proc. Linn. Soc. N.S. Wales, xxii., p. 238 (1897); Cheel: *ibid*, xxxviii., p. 171 (1913); Lloyd: Synopsis Sect. Ovinus of *Polyporus*, p. 86 (1911), and Synopsis of Stipitate *Polyporoids*, pp. 67 and 168 (1912).

The following description is given in Cooke's Handbook:—"Pileus fleshy (3-4 in. diameter), firm, convex, clad with darker innate scales, margin at first incurved; flesh white;

stem short, thick, equal (1-2 in. × 1 in.), solid, ochraceous; mycelium profuse, white, forming a dense mass at the base; tubes adnate, or a little decurrent, broad; pores large, unequal, angular, spores 12 × 4·5 μ, pale olive. On the ground, Queensland."

Lloyd *(l.c.)* states that this is known from but one collection made in Australia, and preserved at Kew (England). "It is quite a distinct thing with a pileus resembling in some respects that of *Polyporus betulinus*. It has a soft, white flesh and a thin, papery, smooth cuticle. The stems are short, thick, and mesopodal. They are so covered with adhering dirt that it cannot be told whether or not they belong in the section with black stems. The pores are large, irregular, and apparently have turned black in drying. Spores not found by me." In a footnote in the same work Lloyd further states:—"On the hard, stony ridges about Brisbane, when trenching the land, large masses of mycelium are often met with. Some of the masses would weigh over a hundredweight. From its consistency one might fancy that a quantity of dough had been buried. My idea has always been that it was the mycelium of some *Boletus*" (quotation from Bailey). Lloyd also states:—"Cooke named this plant *tumulosus*, under the impression that it produced these mycelial masses. I cannot see any direct connection between this fungus in the account as published and these mycelial masses, and I think it is not certain that there is any connection."

In the neighbourhood of Penshurst, near Sydney, one of us has found on several occasions large conglomerate masses of mycelium and earth when digging in the garden, which we believe are referable to this species. On one occasion some undeveloped sporophores of a whitish colour, showing a few large irregular pores, were found arising from one of these masses. Mr. R. T. Baker has also recorded *(l.c.)* this species from specimens collected by Mr. W. Bauerlen at Lismore. In March, 1915, a fine sporophore, together with a conglomerate ball of earth and mycelium, was collected at Casino by Mr. D. J. McAuliffe, and forwarded to us through Mlss LePlastrier. Mr. J. Lalchere, of Wingham, Manning River, also collected portions of earth and mycelium, similar to the above, in July, 1916. The following two collections, though the pilei have glabrous surfaces, perhaps belong to the same species as the preceding:—

(1) Pileus old and partly decayed, 2 in. across, convex and apparently slightly infundibuliform, smooth, pallid, brownish, with blackish streaks (probably from decay). Pores pallid, much decayed. Stem 5 in. long, buried in the ground

except for about 1 in., about $\frac{3}{4}$ in. thick, slightly irregularly nodular, slightly bent. Attached to a large irregular mycelial mass, several inches long, composed of sandy particles and pieces of sandstone loosely agglomerated by mycelium, apparently confined by a thin reddish-brown crust. Spores white, elongated, shaped like typical *Boletus* spores, 10·4 × 3·4 to 4 μ. Milson Island, Hawkesbury River, March, 1916.

(2) Pileus 2 in. in diameter, convex, smooth, pale brownish. Pores rather large, slightly decurrent, partitions thin, orifice slightly dentate, pale brownish. Stem 1 in. long, under $\frac{1}{2}$ in. thick, roughish, pallid brownish, succeeded by a narrower irregular root $1\frac{1}{4}$ in. long, black on the outside (? from the soil) and white within. In a dry swamp attached to a large circumscribed mass 7 × 4 × 3 in. in size, composed of black sandy soil held together by whitish mycelial threads, but without a crust. Spores elongated, rather like those of *Boletus*, white, 12 to 16·5 × 4·2 to 5 μ. Narrabeen, March, 1916.

The following is a description of the specimen collected at Casino by Mr. D. J. McAuliffe in March, 1915:—Pileus 3 to 4 in. across, more or less velvety tomentose, pallid or cream colour, tending to buff colour with age; margin involute; pores rather large, angular, pallid white. Stem nearly 5 in. long, up to 1 in. thick, the upper part pallid, the lower part more or less covered with mycelial threads and adhering soil. Spores not seen. The false sclerotium sent with the sporophore measured about 3 to 4 in. across.

88. *Polyporus basilapiloides* (McAlp. and Tepper); *Laccocephalum basilapiloides*, McAlp. and Tepper: Proc. Roy. Soc. Vict., vol. vii., (N.S.) p. 166 (pl. x.), 1894; *Polyporus* (section Amaurodermus) *basilapidioides*, Lloyd: Syn. Sect. Ovinus of *Polyporus*, p. 76, 1911, and Syn. Stipitate Polyp., p. 115 (1912).

McAlpine and Tepper described this species and placed it in a new genus *Laccocephalum*. The characteristics of this proposed genus are that the plants are hard and woody from the first, that the pileus is peculiarly pitted, and that the spores are large, spherical, and coloured. On the strength of the lastnamed Lloyd placed the species under the designation *basilapidioides*, in the section Amaurodermus. The spores, however, are white, and not coloured. The plant probably belongs to the section Ovinus, with other species forming true or false sclerotia. Though hard and woody to touch externally, the section of the stem of one of the specimens we examined was, though firm and resistant, velvety to the touch. We would question further, therefore, the generic

definition of "hard and woody from the first," believing that growing plants will not be found to possess these characteristics, though the surface of old dried plants, which are most likely to be found, will suggest these qualities. The genus *Laccocephalum* cannot, we feel sure, stand on the pitted surface of the pileus alone. We have examined the type, as well as three other false sclerotia, one with a pileus, in the Herbarium of the University of Adelaide; five complete specimens in the South Australian Museum; another complete specimen and two false sclerotia in the Museum of the Department of Agriculture, Melbourne; and one false sclerotium in the National Herbarium, Sydney. We give descriptions of these in full. It will be noted that two specimens, one in Melbourne and one in Adelaide, differ from the others in having a strongly tuberculate crinkled edge to the pileus; also that, whilst the pitting, or alveolation, is marked in some plants, it is barely recognizable in others.

The following are in the Herbarium of the University of Adelaide:—

(1) Type specimen, labelled "*Laccocephalum basilapiloides*." Pileus $3\frac{1}{2}$ in. in diameter, convex, rather irregular, the centre a little depressed, dull pallid stony-white, pitted with irregular very shallow alveoli. Pores slightly decurrent, small, the colour of the cap. Stem $\frac{7}{8}$ in. high, $\frac{5}{8}$ in. thick, pallid brownish-white, slightly flattened. The false sclerotium is somewhat flask-shaped with a flattened base, 3 in. high by $3\frac{1}{2}$ in. broad, the surface somewhat irregularly nodular; it is apparently composed of sandstone particles or sand, welded by a mycelium into a firm mass, which can, however, be disintegrated into particles by scratching with the finger. From South-eastern District of South Australia (A. Molineux).

(2) Pileus $2\frac{3}{8}$ in. in diameter, convex, slightly depressed in the centre, slightly fibrillose, no pitting, dirty white with greyish areas from weathering. Pores a little larger than in the type specimen. Stem $\frac{1}{2}$ in. high and $\frac{1}{4}$ in. thick. False sclerotium irregular, somewhat ringed, $2\frac{1}{2}$ in. high, $1\frac{1}{2}$ in. broad. Allawoona, Brown Hill Line, May, 1914 (S. G. Taylor, engineman, Murray Bridge).

(3) and (4) Two false sclerotia; localities not noted.

The following, in the South Australian Museum, have been examined by us:—

(5) Pileus 2 in. across, deeply convex, pallid white from weathering, the surface areolarly pitted in a very shallow way, the alveoli $\frac{1}{8}$ in. in diameter, the septa with thin edges. Pores adnate, medium small. Stem $\frac{5}{8}$ in. high, $\frac{1}{4}$ in. across in the middle, expanding a little upwards and downwards. The

false sclerotium $2\frac{1}{2}$ in. high and 2 in. wide. Loxton District, 19/10/14 (Mr. H. R. Parnell, Librarian, Public Library).

(6) Pileus $1\frac{3}{4}$ in. across, with indistinct alveolar markings, and in the centre several irregular pits, pallid white from weathering. Pores adnate, medium size, pallid brownish. Stem $\frac{3}{4}$ in. high, $\frac{1}{4}$ in. thick in the middle, a little thickened upwards and downwards. False sclerotium irregular, $1\frac{1}{2} \times 1\frac{1}{4}$ in., a piece of *Mesembrianthemum* embedded in it. Locality not noted. (Mr. Jas. R. Beck, "Kircaldy," Wyandra.)

(7) This is the freshest specimen we have seen. Cap 2 in. across, convex, edge rather inturned, smooth, rather polished, showing small alveolar depressions, sometimes indicated merely by raised darker lines, irregularly tinted with chestnut to yellow-brown. Pores adnate, medium sized, pallid-biscuit tinted. Stem $\frac{1}{2}$ in. high and $\frac{1}{2}$ in. thick, the colour of the pores, rather sand incrusted, apparently slightly irregularly pitted as if from the presence of aborted pores; flesh of the stem firmish, villous to touch. False sclerotium $1\frac{1}{2}$ in. high, $1\frac{1}{4}$ in. broad, composed of sand bound together by mycelium, easily disintegrated by scratching.

(8) Pileus 5 in. across, with the centre depressed and the rest of the surface nearly plane, the edge consisting of large irregular tuberculate projections marked off by a slight depression from the plane surface of the cap, colour dull white from exposure. Pores rather small. Stem $\frac{3}{4}$ in. high and broad. False sclerotium irregular, 3 in. broad and $1\frac{1}{2}$ in. high. (Presented by Mr. H. E. Ellis, Kensington Park, Adelaide.)

By the kind permission of the Board of the Public Library, Museum, and Art Gallery of South Australia, and the courtesy of the Museum Director, Mr. Edgar R. Waite, we are able to show photographs (pl. iv.) taken under Mr. Waite's supervision of this remarkable specimen. A specimen in the Museum of the Department of Agriculture, Melbourne, closely resembles this one. The alveolar markings on the cap are absent or ill-defined in both.

(9) Pileus 3 in. across, slightly convex and wavy, centre a little depressed, slightly irregularly rugose and shallowly lacunose, smooth, pale brownish. Pores adnate, small, pallid wood colour. Stem $\frac{1}{2}$ in. thick and broad, finely lacunose, pale wood colour. False sclerotium 3 in. high, 4 in. broad, irregular and rather knobby, composed of pallid brownish sandy particles welded together, easily disintegrated by attrition. Spores white, elongated, 12 to $15{\cdot}5 \times 5\ \mu$. Lake Alexandrina, South Australia. (Mr. J. A. Burrough.)

The following are in the Museum of the Department of Agriculture, Melbourne:—

(10) Pileus 4 in. across, slightly convex, edge irregularly crenate, rather alveolate, pallid whitish. Pores adnate, brownish. Stem $\frac{3}{4}$ in. high and broad. False sclerotium 4 in. high, 3 in. broad, outer crust hard, the inside capable of being scratched away. Locality not stated.

(11) Pileus 2 in. across, glazed whitish with fine anastomosing lines. Pores adnate, pale brownish. Stem $\frac{3}{4}$ in. high, $\frac{1}{2}$ in. broad, brownish, finely areolate. False sclerotium 2 in. high, $\frac{1}{2}$ in. broad.

(12) Three small false sclerotia, all from the mallee, Victoria.

The following is in the Melbourne National Museum:—

(13) "Mallee Potato." Sand held together by fungous threads; ploughed up at Nyall mallee; forwarded by Mr. Thomas J. Jenkins, 21/6/11.

The following is in the National Herbarium, Sydney:—

(14) One false sclerotium, somewhat bottle-gourd shaped, about the size of a child's head, with the neck part cut through by a ploughshare. The outer crust consists of rusty-coloured particles of sand bound together, the inner part of whitish mycelial strands and earthy and sandy matter welded together, of a similar colour and somewhat resembling cement. Forwarded from Rappville by Mr. A. Spedding through Mr. G. Marks, manager of the Grafton Experiment Farm. Mr. Marks reported that these false sclerotia are usually found in sandy soil at a depth of 4 to 6 in. They are brought up to the surface during the ploughing operations, and when first unearthed the specimens are somewhat soft, but harden upon exposure to the weather. Other false sclerotia have been found near Grafton and at Casino. Similar specimens were submitted to the Chemical Branch, Department of Agriculture, and the following is a copy of a report made by Dr. H. I. Jensen:—"The specimen of stone-making fungus was found to contain only 7·2 per cent. of organic and volatile matter, the balance being earth. On ignition the material first blackens, and then gives off heavy organic fumes with a disagreeable smell like burning bones and rags. On the destruction of all the organic matter, a pinkish-yellow earth remains. The specimen contains no carbonates of lime or iron, the cementing material seeming to be essentially fibres of organic matter. The exterior has a sandy crust, in which rather more oxide of iron has been deposited than in the more organic core."

89. In these Proceedings (vol. xlii., 1918, p. 297) Mr. Walter Howchin, on behalf of the Museum Director, exhibited and described a sand-cementing false sclerotium obtained near Balaklava by the Rev. J. Blacket. To make this series complete, by the kind permission of the Board of the Public Library, Museum, and Art Gallery of South Australia, and the courtesy of the Museum Director, Mr. Edgar R. Waite, we are able to reproduce an excellent photograph of this specimen (fig. 3, pl. v.).

DESCRIPTION OF PLATES I. TO V.

PLATE I.

Fig. 1. *Polyporus mylittae.* Reproduction of part of a water-colour sketch, made by Mr. R. T. Baker, of the sporophore described by him. Reduced by half.

Fig. 2. *Polyporus minor-mylittae.* Water-colour sketch by Miss P. Clarke. Natural size.

PLATE II.

Figs. 1 and 2. *Polyporus mylittae.* Photographs of the sclerotium of a Western Australian specimen, reproduced by kind permission of Dr. F. Stoward. Measurements in inches.

PLATE III.

Figs. 1 and 2. Photographs of one of the sclerotia described under 83. Measurements in inches.

PLATE IV.

Figs. 1 and 2. *Polyporus (Laccocephalum) basilapiloides.* Reproduced by kind permission of the Board of the Public Library, Museum, and Art Gallery of South Australia.

PLATE V.

Fig. 1. *Polyporus minor-mylittae.* Sporophores just forming.

Fig. 2. *Polyporus minor-mylittae.* Sporophore partly developed, showing partial absorption of the sclerotium at the base.

Fig. 3. Photograph of the false sclerotium referred to under 89. Reproduced by kind permission of the Board of the Public Library, Museum, and Art Gallery of South Australia.

ADDITIONS TO THE FLORA OF SOUTH AUSTRALIA. NO. 15.

By J. M. Black.

[Read May 8, 1919.]

Plates VI. to VIII.

This paper contains notes on specimens collected by Mr. E. H. Ising in the Flinders Range, near Moolooloo head station, from September 30 to October 11, 1918; by Dr. W. A. Cannon in our Far North during last winter; by Capt. S. A. White, Mr. H. W. Andrew, and others in various parts of the State; and by myself during an excursion along the Pinnaroo railway in October last.

Three species believed to be new to science—*Kochia Cannonii*, *Pimelea Williamsonii*, and *Goodenia vernicosa*—are described and figured. A new variety of *Hibbertia virgata* is described, and an effort has been made to arrange the South Australian species of *Calamagrostis* and *Microcybe*.

The following Australian species are recorded for the first time in this State:—*Loranthus miraculosus*, *Microcybe multiflora*, *Stipa arachnopus*, *Dodonaea cuneata*, *Marsilia hirsuta*, *Goodenia Nicholsonii*, *Eucalyptus Morrisii*, *Calamagrostis minor*.

The following new aliens are recorded:—*Gastridium lendigerum*, *Eragrostis major*, *Ehrharta villosa*, *Chenopodium Vulvaria*, *Anacyclus radiatus*.

Marsiliaceae.

Marsilia hirsuta, R.Br. Pinnaroo; growing in marshy ground. Not previously recorded for South Australia. Leaflets 4-6 mm. long, more or less villous below; involucres villous, sessile or almost so.

Pinaceae.

Callitris verrucosa, R. Br. Yumali (S. A. White); scrub south of Lameroo. A shrub or small tree, often under 2 m. high. Near Ooldea (W. A. Cannon).

C. robusta, R. Br. Common near Lameroo; a tree 4-6 m. high, usually with the stem bare up to about 3 m., the branches then spreading so as to form an ovoid head. Enfield, with the cones sometimes slightly warted.

C. propinqua, R. Br. In the "Pinery," on the road from Lameroo to Winnike Berick. A good-sized tree, the branches

often springing not far from the ground. The fruits vary in size on the same tree, and can sometimes be found scarcely larger than those of *C. robusta.*

GRAMINEAE.

Eriochloa punctata, (L.)., Hamilt. Frome River near Marree (Hergott).

Pappophorum avenaceum, Lindl. Common at Marree.

Eragrostis falcata, Gaud. non Benth. *(E. lacunaria*, F. v. M.). Berri, Lake Bonney, and other places along the Murray; Everard Range (S. A. White). Plate 25, which accompanies Gaudichaud's description of *E. falcata*, and which shows the spikelets distinctly pedicellate, rather distant, and not clustered, supports the statement in Diels et Pritzel, Fragm. phyt. Austr. occ. 76, that the original specimen of Gaudichaud's plant, preserved in the Berlin Herbarium, belongs to the species described in the Fl. Aust., vii., 649, as *E. lacunaria*, F. v. M.

E. Dielsii, Pilger. *(E. falcata*, Benth. non Gaud.). Berri and along the Murray; Marree; Oodnadatta; Mulka (R. Cockburn); Strzelecki Creek (S. A. White); also Broken Hill, N.S.W. Stems stouter than in *E. falcata*, Gaud., and spikelets more curved.

**E. major*, Host. Roadside near Berri (C. G. Savage). This European grass has already been recorded in Victoria and New South Wales. It is said that cattle will not eat it on account of the obnoxious smell of the leaves when fresh, and in North America it is known as "Stinking grass." In 1912 (these Trans., xxxvi., 172) I recorded the occurrence of **E. minor*, Host., at Alice Springs, N.T., and Broken Hill, N.S.W., so that it probably occurs in our north-eastern country, although I have no specimens from South Australia. These two grasses resemble each other, both having a row of glands or tubercles along the margins of the leaf-blade, but *E. minor* is a smaller plant, with a looser panicle, narrower spikelets (1½-2 mm. broad), and the leaf-sheath is sprinkled with tubercles, many of which carry long hairs. *E. major* has glabrous sheaths, and the spikelets are 3 mm. broad.

Rottboellia compressa, L. f. *(Hemarthria compressa*, R. Br.). Bridgewater (H. W. Andrew); beside River Onkaparinga, Woodside. The sessile spikelet is 8-9 mm. long, and has only 1 stiff, green outer glume, the 2 inner glumes being hyaline, with a short palea in the uppermost one. The pedicellate spikelet is 10 mm. long, has 2 stiff outer glumes, 2 hyaline inner ones, and a palea. It therefore appears probable that the second outer glume of the sessile spikelet exists, but is adnate to, and obliterated in the rhachis, as described

by Kunth (Enum., i., 464). All the pedicellate spikelets which I examined contained a bisexual flower, the same as the sessile ones.

Stipa arachnopus, Pilger in Engl. Jahrb., xxxv., 70 (1904). Nullabor Plain (per Dr. R. S. Rogers); Peterborough; Enfield; Pinnaroo. Our specimens seem to me to agree with the description in all particulars except that the awn varies in length from 3½ to 7 cm. The numerous young shoots in the tuft consist of subulate, rigid, almost pungent-pointed leaves, hispid with spreading hairs. From among these arise the nodeless stems to a height of 30-40 cm., including a panicle 15-20 cm. long; the long uppermost leaf-sheath, which has a subulate blade much shorter than the sheath, usually clasps the base of the panicle; the awn is distinctly hairy in the lower part. If the determination is correct, this is the first record for South Australia of this Western Australian grass.

Agropyrum scabrum, (Labill.), Beauv. Ferguson Gorge, near Moolooloo (Dist. S; E. H. Ising).

Stipa scelerata, Behr. Scrub at Enfield (Dist. A).

Danthonia penicillata, (Labill.) F. v. M. Pinnaroo (Dist. M).

Panicum leucophaeum, H. B. et K. Golden Grove (Dist. A; H. W. Andrew). Probably introduced by stock from some northern part of the State.

**Ehrharta longiflora*, Sm. Moolooloo (E. H. Ising).

**Phalaris paradoxa*, L. Railway reservoir, Hindmarsh Valley (H. W. Andrew). First record for the mainland: previously found on Kangaroo Island.

**Alopecurus pratensis*, L. Tantanoola (H. W. Andrew). Growing in crops as high as the wheat and oats.

**Gastridium lendigerum*, (L.) Gaudin. Black Forrest; Hindmarsh Valley; roadside north of Port Elliot (H. W. Andrew); Wirrabara (Tate Herbarium); Mount Barker; Myponga; Cummins, E.P. Called in England "Nitgrass." First record for South Australia and, as far as I know, for Australia, but must have existed in our State for many years, as I first collected it at Mount Barker in 1903, and the specimen from Wirrabara in the Tate Herbarium (placed without date under *Calamagrostis quadriseta*) must have been gathered several years earlier. This grass bears considerable resemblance to the native *C. quadriseta*, but the panicle is denser, spike-like, and silvery-shining, at least after flowering; the outer glumes are swollen and shining at the base, the lower one 5-6 mm. long and slightly incurved. A native of Southern and Western Europe, and introduced in Texas, California, and Chili.

**Ehrharta villosa*, Schult. f., var. *maxima*, Stapf. Sand dunes south of Glenelg (S. Dixon); Clarendon; Streaky Bay, E.P. (per H. W. Andrew). A valuable sand-binding grass; flowers October-November. Introduced to the State in recent years, and has established itself in several places. The identification was confirmed by the Kew authorities. A native of South Africa.

South Australian Species of Calamagrostis.

Panicle loose; bristle present.	
Flowering glume hairy, half as long as the outer glumes; awn attached near middle of flowering glume	*C. aemula*
Flowering and outer glumes longer, the flowering glume glabrous; awn attached below middle; maritime grass	var. *Billardieri*
Panicle dense or slightly lobed; flowering glume nearly as long as outer glumes.	
Awn almost basal.	
Bristle absent	*C. quadriseta*
Bristle present	var. *montana*
Awn attached near middle of flowering glume.	
Bristle absent	*C. minor*
Bristle present	var. *densa*

The arguments for uniting *Deyeuxia* with *Calamagrostis* are fortified by the character of our Australian species. These are all distinguished from *Agrostis* by the conspicuous tuft of hairs on the callus of the flowering glume (rhachilla, or axis of the spikelet), but some of them have a hairy bristle (pedicel of an obsolete second flower) rising at the base of the palea and continuing the rhachilla *(Deyeuxia)*, while others have no such bristle *(Calamagrostis)*. The remaining differences, however, are not such as would justify a classification under distinct genera, or even, in many instances, under distinct species. In our plants the other differences appear to me to be sometimes so slight as to be merely varietal.

Calamagrostis quadriseta, (Labill.) Spreng. *(Deyeuxia quadriseta*, Benth.) Mount Lofty; Aldgate; Belair; Bridgewater; Clarendon; Myponga; Cygnet River, K.I.; Wilpena Pound (the last two from the Tate Herbarium). Grass 50-120 cm. high; panicle 5-13 cm. long, compact but usually somewhat lobed; outer glumes keeled, subequal, 3½-5 mm. long; flowering glume 2¼-4 mm. long, 4-toothed, narrow, minutely scabrous; awn almost basal, usually shortly exserted, but sometimes included; tuft of hairs more or less surrounding the callus; grain fusiform, 2 mm. long, the membranous pericarp loose toward the summit; hilum shortly linear.

Var. *montana*, Ewart. *(Deyeuxia montana*, Benth.) I have only inserted this variety because Bentham gives it for

"Lofty and Bugle Ranges, *F. Mueller*," in Fl. Aust., vii., 581. I have not been able to find any specimen bearing the bristle, either in my own collection or in the Tate or Menzel Herbaria. Professor Ewart, in reducing *D. montana* to a variety of *D. quadriseta*, says (Vict. Nat., xxiv., 13), "These species are both very variable and run into one another at all points."

C. minor (Benth.) combin. nov. *(Deyeuxia minor*, Benth.). A new record for South Australia. I have only one specimen, collected at Mount Lofty in December, 1908, by H. Griffith. A slender grass; panicle 4 cm. long, slightly lobed; outer glumes broad, subequal, the lower 4 mm. long, the upper one a litle longer; flowering glume broad, 3 mm. long, 4-toothed, scabrous, especially on the nerves; awn attached near the middle of the flowering glume and shortly exserted, hairs of the callus rather long, especially behind the palea, but no bristle. Our specimen agrees with one from Southport, Tasmania, kindly given me by Professor Ewart.

Var. *densa*, (Benth.) combin. nov. *(Deyeuxia densa*, Benth.). Blackwood (H. Griffith); Crafers (Tate Herbarium); quoted in the Fl. Aust., vii., 582, for "Lofty Ranges and Onkaparinga, *F. Mueller*." Bentham describes the panicle as "dense and spike-like or slightly lobed, 2 to 3 in. long." A specimen without locality lent me by Prof. Ewart has the panicle 5 cm. long and rather dense, but our own specimens have a longer and more lobed panicle, 8-16 cm. in length. Outer glumes subequal, 4½-5 mm. long; flowering glume rather narrow, scabrous, 3½-4 mm. long, the awn attached a little above the middle and shortly exserted; the bristle hairy and half as long as the palea; grain fusiform, 2 mm. long. The 4 teeth of the flowering glume are less conspicuous in the Tasmanian specimen than in ours. If it were proposed to retain this grass as a species in *Calamagrostis*, a new specific name would apparently be required, because *C. densa*, Vasey in Coult. Bot. Gaz., xvi., 147 (1891), a Californian grass, would be able to claim priority over *C. densa* (Benth.) Maiden et Betche, Cens. N.S. Wales, pl. 21 (1916).

CYPERACEAE.

Carex Bichenoviana, Boott. Paradise (H. W. Andrew). Style-branches sometimes 2 instead of 3. Mr. R. A. Black records (Proc. Roy. Soc. Tas., 1916, p. 145) the re-discovery of this plant in a damp situation on Mount Direction, near Hobart.

Cyperus tenellus, L. Monbulla scrub, S.E. (Dist. T; H. W. Andrew).

Carex tereticaulis, F. v. M. Ferguson Gorge, near Moolooloo (E. H. Ising). Approaching *C. chlorantha*, R. Br., in its short panicle (5 cm. long), spike-like but interrupted towards the base, and tending towards *C. appressa*, R. Br., in its subtrigonous stems and leaves scabrous on the margin in the narrow upper portion.

Centrolepidaceae.

Centrolepis polygyna, Hieron. Soak at Winnike Berick, south of Lameroo.

Juncaceae.

Juncus holoschoenus, R. Br. Monbulla scrub (H. W. Andrew); Dismal Swamp, S.E.; Waterfall Gully; Myponga. Our specimens agree with Brown's characters—stem cylindrical or nearly so; stamens 6; capsule equalling the perianth; also with Buchenau's character of the complete septa in the leaves. The plants from Monbulla and Dismal Swamp are dwarf. It appears doubtful whether we possess *J. prismatocarpus*, R. Br., in South Australia. All the specimens so named in the Tate Herbarium (from Waterfall Gully, Reedbeds, Mannum, Wirrabara, and Wilpena) are *J. holoschoenus*.

J. pallidus, R. Br. Banks of Torrens Lake; Waterfall Gully; Slape Gully; Myponga; Nuriootpa; Woodside; Mount Gambier; Glencoe; Dismal Swamp. This species, as correctly defined, has always 6 stamens; capsule 3-4 mm. long, pale coloured and usually exceeding the perianth considerably; stems stout, with continuous pith.

Liliaceae.

Thysanotus Patersonii, R. Br. Pinnaroo (Dist. M).

Casuarinaceae.

Casuarina Luehmannii, R. T. Baker. "Bull Oak." Few miles south of Lameroo. Tree 8-10 m. high, with rough, brown bark; lowest branches drooping, uppermost spreading-erect; trunk usually without branches for 2 m. above the ground; internodes to 20 mm. long; young cones tomentose.

C. lepidophloia, F. v. M. Oodnadatta (Dist. C); W. A. Cannon); sheathing teeth 9-11. Willigin Water, near Moolooloo (E. H. Ising); teeth 11-12. *C. lepidophloia* was described by F. v. Mueller in 1877; Bentham, in dealing with this genus in 1873 (Fl. Aust., vi., 196), placed specimens of *C. lepidophloia* under *C. glauca*, Sieb. Mueller distinguishes the former species as having 9-10 sheathing teeth; *C. glauca*, as now understood, "having usually 15 in the whorl, varying from 12-16" (J. H. Maiden, For. Fl. N.S. Wales, ii., 95). Mr. Maiden is of opinion that *C. glauca* has not yet been

found in South Australia, but a specimen without fruit, which I collected in the Yappala Hills, near Hawker, from trees locally called "Black Oak," has the branchlets fully 2 mm. in diameter and 14-16 teeth. Unfortunately I have no note as to the bark. The branchlets of our northern specimens of *C. lepidophloia* are greyish or hoary with a minute pubescence, 1-1½ mm. in diameter, and readily separating at the nodes; the cones vary from subglobular to oblong, 15-25 mm. in length and 15-20 mm. in diameter, the valves in 8-9 rows.

C. suberosa, Otto et Dietr. Lameroo. Sheathing teeth 5-6, short and appressed; male spikes 1-4 cm. long.

PROTEACEAE.

Hakea ulicina, R. Br., var. *flexilis*, F. v. M. South of Lameroo.

H. Ednieana, Tate. Witcher Well, near Moolooloo (E. H. Ising).

Grevillea aspera, R. Br. Mount Patawurta (Dist. S; E. H. Ising).

Adenanthos terminalis, Labill. Coonalpyn. (Dist. T; H. W. Andrew).

LORANTHACEAE.

Loranthus miraculosus, Miq. (*L. pendulus*, Sieb., var. *parviflorus*, Benth.). Robe (S. A. White); Port Vincent Y.P. (growing on *Melaleuca parviflora)*; Ooldea (S. A. White). Leaves 1-6 cm. long, thick, nerveless, oblanceolate; the central flower in each partial cyme is sessile; corolla 15-20 mm. long.

SANTALACEAE.

Exocarpus spartea, R. Br. Scrub at Enfield; Murray Scrub; 90-Mile Desert. An erect broom-like shrub, usually 3-4 m. high, the ultimate branches drooping; pedicels at first cylindrical, thick and green, then remaining unchanged or swelling until they are globular, succulent, whitish, and as large as, or larger, than the fruit; fruit ovoid, 4-5 mm. long, at first green, but when ripe becoming orange or a rich brown.

POLYGONACEAE.

Muehlenbeckia stenophylla, F. v. M. Common in the Trans-Murray scrub at Karoonda, Lameroo, and Pinnaroo.

CHENOPODIACEAE.

Kochia Cannonii, *nov. sp. (tab. vi.). Fruticulus sericeo-tomentosus, ramis di-trichotomis, foliis aut omnino aut fere oppositis oblongis crassis obtuse trigonis 7-8 mm. longis 2-3 mm. latis apice acutis et recurvis vel fere uncinatis, floribus*

axillaribus, perianthio fructifero depresso, tubo brevissimo, lobis latis planiusculis pubescentibus alâ integrâ annulari membranaceâ horizontali 5-6 mm. diam. circumdatis.

Plain west of Leigh Creek (Copley) railway sation (W. A. Cannon); near Port Augusta (Tate Herbarium); Telowie.

This species has the succulent, trigonous, subopposite leaves of *K. oppositifolia*, F. v. M., but they are longer and recurved or almost hooked at the summit, while the horizontal wing of the fruiting perianth is entire, and resembles that of some of the small-fruited forms of *K. villosa*, Lindl. Dedicated to Dr. W. A. Cannon, of the Carnegie Institution of Washington (Department of Botanical Research), who visited South Australia in 1918 to study the root-systems of our dry-country plants. He brought from Leigh Creek fruiting specimens of this *Kochia*, and on looking through my herbarium I found a similar specimen, without fruits, which I gathered in the Hundred of Telowie, near the coast, in 1906, and placed tentatively with *K. oppositifolia*. The Tate Herbarium contains, similarly placed, a specimen with 2 fruits, collected near Port Augusta.

K. eriantha, F. v. M. Leigh Creek (W. A. Cannon).

K. planifolia, F. v. M. Leigh Creek (W. A. Cannon). Leaves to 14 mm. long and appearing flat when dried, but when fresh I have found them rather cigar-shaped and very slightly compressed. They differ from those of *K. sedifolia* in being shortly, but distinctly, petiolate.

Chenopodium microphyllum, F. v. M. Mount Patawurta (Dist. S; E. H. Ising).

**Chenopodium Vulvaria*, L. "Stinking Goosefoot." Tantanoola District, 1918; growing in gardens and among potato crops (H. W. Andrew). This European weed, distinguished by its unpleasant and persistant smell of stale fish, has not previously been recorded for South Australia. It seems to be a somewhat recent introduction to Australia. According to Prof. Ewart (Weeds, etc., of Vict., 75) it was first recorded for that State in 1908; C. Moore does not mention it in his Fl. N.S. Wales (1893), or F. M. Bailey in his Weeds, etc., of Queensland (1906).

PHYTOLACCACEAE.

Codonocarpus pyramidalis, F. v. M. Ferguson Gorge, near Moolooloo (E. H. Ising). Fruits ripe (October 9). "A tree 5 m. high, with straight, smooth trunk; branches horizontal."

NYCTAGINACEAE.

Boerhaavia repanda, Willd. Parachilna Gap (E. H. Ising).

Caryophyllaceae.

Scleranthus minusculus, F. v. M. Pinnaroo. This little plant, although well protected by its pungent leaves and calyx-lobes, appears to be rather rare. I only found one specimen. It has previously been recorded from Murray Bridge.

S. pungens, R. Br. Moolooloo (Dist. S; E. H. Ising).

**Moenchia erecta*, Gaertn. Blackheath, near Harrogate (H. W. Andrew). Already recorded from the South-East.

**Lychnis alba*, Mill. (*L. vespertina*, Sibth.). "White Campion." Headlands of experimental plots at Cromolite, on the South Australian portion of the railway from Mount Gambier to Portland. Recorded as a weed for Victoria, but not previously observed in this State.

**Silene venosa* (Gilib.), Aschers. "Bladder Campion." North Park Lands; fields near Enfield, as well as in the hills. The principal synonyms of this species are:—

Cucubalus Behen, L. Sp. pl. 414 (1753).
C. latifolius, Mill. Gard. Dict., ed. 8, n. 2 (1768).
C. venosus, Gilibert. Fl. lituan., ii., 165 (circa 1782).
Behen vulgaris, Moench. Meth. 709 (1794).
Cucubalus inflatus, Salisb. Prodr. 302 (1796).
Silene Cucubalus, Wib. Prim. fl. werth. 241 (1799).
S. inflata, Sm. Fl. brit. ii. 467 (1800).
S. Behen, Wirzén. Enum. pl. offic. Fenn. 36.
S. venosa, Aschers. Fl. Brandenb. i. 86 (864).
S. vulgaris, Garcke. Fl. Deutschl., ed. 9, 64 (1869).
S. latifolia, Britten et Rendle. List Brit. seedpl. 5 (1907).

It is clear that when this species is transferred from *Cucubalus* to *Silene* the correct combination would be *S. Behen*, were it not that this name had been already adopted for another species by Linnaeus (Sp. pl. 418). Neither is *S. latifolia*, Britten et Rendle, admissible, because a distinct North African species had already received this name from Poiret (Voy. Barb., ii., 165). Therefore Ascherson's combination appears to be the correct one.

Ranunculaceae.

**Ranunculus trachycarpus*, Fisch. et Mey. Common in water at Murray Bridge. This species seems scarcely to differ from *R. sardous*, Crantz, except in the somewhat straighter and thicker beak of the carpel, and it should perhaps be treated, as Fiori does in his Flora analitica d'Italia, as a variety of that species. The beaks in some of our specimens are often slightly curved.

**Adonis autumnalis*, L. "Pheasant's eye." Near Blyth; a few specimens; apparently localized.—Europe and Western Asia.

LAURACEAE.

Cassytha melantha, R. Br. Mount Patawurta, near Moolooloo (Dist. S; E. H. Ising).

CRUCIFERAE.

**Coronopus didymus*, (L.) Sm. (*Senebiera didyma*, Pers.; *S. pinnatifida*, DC.). Common at Murray Bridge and Bordertown.

**C. procumbens*, Gilib. (*Senebiera Coronopus*, Poir.). Growing luxuriantly at Naracoorte and Penola (H. W. Andrew).

Lepidium hyssopifolium, Desv. Morgan (B. Beck); Pinnaroo.

DROSERACEAE.

Drosera Menziesii, R. Br. Yumali (Dist. T; S. A. White).

CRASSULACEAE.

Crassula bonariensis, (DC.) Cambess. (*Tillaea peduncularis*, Sm.; *T. purpurata*, Hook. f.). Soak at Winnike Berick, about 10 miles south of Lameroo (Dist. M). Carpels 8-13-seeded.

C. Sieberiana, (Schult.) Ostenf. Contrib. W.A. Bot., ii., 44 (1918). (*Tillaea Sieberiana*, Schult.) Pinnaroo; Moolooloo (E. H. Ising).

LEGUMINOSAE.

Acacia spinescens, Benth. Yumali (Dist. T; S. A. White).

A. tarculensis, J. M. Black. Tarcoola (W. A. Cannon). Locally called "Steel bush," from the greyish or glaucous appearance of the leaves; pods still unripe (September 6, 1918), thick but flat, 30-35 mm. long, 5 mm. broad, silky-pubescent.

A. brachystachya, Benth. Near Leigh Creek (Dist. S; W. A. Cannon).

A. sublunata, Benth. Hills five miles north of Quorn (W. A. Cannon, July, 1918). Mueller considered that his *A. parvifolia* was a species distinct from *A. sublunata*; Bentham (Fl. Aust., ii., 378) united them. Tate recorded both species (Fl. Extra-trop. S.A., 75), but his herbarium contains no specimen of either. Dr. Cannon's specimen (the only one I have seen) has no flowers except a few dry ones hanging round the branch. Many detached bracteoles are also present; they are membranous, very concave, almost semi-globular, and must enfold the flowers to a degree not usual in

Acacia. They are quite obtuse and show no points, at least at this advanced stage; in this respect they agree with the description of *A. parvifolia*, but the peduncles of the unripe, spirally-twisted pods are almost as long as the leaf, which scarcely conforms to Mueller's "capitulis subsessilibus vel breviter pedunculatis." As the only distinction between the two descriptions lies in the shape of the bracteoles, the length of the peduncles, and the density of the indumentum, it appears safer, at least until we have further material, to follow Bentham in treating them as forms of one species. This plant, which was found growing with *A. calamifolia*, seems rare or localized. The types of *A. sublunata* and *parvifolia* both came from South Australia.

A. pycnantha, Benth. Scrub south of Lameroo (Dist. M).

A. microcarpa, F. v. M. Scrub near Lameroo, Pinnaroo, and Jabuk. A low shrub with several stems rising from the ground-level or even below it; branches diffuse. The tallest plants were not more than 1 m. high, and some were only half that height. The phyllodial gland is usually present at a considerable distance from the base.

A. brachybotrya, Benth. Pinnaroo. A low shrub; branchlets, phyllodes, and peduncles beset with spreading but not silvery hairs, those on the phyllodes falling off with age; calyx obtusely lobed, half as long as the petals, which are pubescent in the upper part, especially along the midnerve, and separate readily.

A. rivalis, J. M. Black. Willigin Water, near Moolooloo (E. H. Ising). Towards the summit of the branchlets the inflorescence is often racemose, each peduncle having only 2 minute stipular bracts at its base.

A. Oswaldii, F. v. M. Mount Patawurta (Dist. S; E. H. Ising).

Templetonia Battii, F. v. M. Fowler Bay, summer, 1879 (Tate Herbarium). Originally described by Mueller in the Melb. Chemist, n.s., ii., 31 (1887), and quoted for Western Australia and South Australia in the 2nd Census (1889). The specimen in the Tate Herbarium is labelled "*Bossiaea Battii*"; this has been struck out and "*Templetonia Battii*" substituted. In his Flora of Extra-tropical South Australia, 65 (1890), Professor Tate described the plant very shortly as *Bossiaea Battii*, Tate. The specimen in the Tate Herbarium, which is presumably a co-type, is certainly a *Templetonia*, the anthers being alternately long and short, the long anthers basifixed and the short ones dorsifixed. The plant has the habit of *T. aculeata*, Benth., but appears to be quite leafless. In the small flowers, the almost orbicular bracteoles, the

glabrous calyx with the lowest lobe longer than the others, it resembles *T. egena*, Benth., but the broad, flat style differentiates it from this and probably from all other *Templetonias.*

Dillwynia uncinata, (Turcz.) J. M. Black. Scrub south of Lameroo.

Pultenaea tenuifolia, R. Br.. Specimens from Robe have the calyx 3½ mm. long and the standard 4-5 mm. long, but those from Strathalbyn, Port Lincoln, Yumali, and Lameroo have the calyx 4-6 mm. long and the standard about 8 mm. long. The petals of the Port Lincoln specimen appear to be chiefly yellow, but on the eastern side of the Gulf the standard is red on the back, yellow in front, the wings yellow, and the keel dark red. The acuminate lobes of the calyx are always villous and the tube glabrous, the bracteoles oblong, scarious, inserted just below the calyx and almost equalling it in length. The leaves vary from softly villous to almost or quite glabrous.

**Trifolium resupinatum*, L. Naracoorte (H. W. Andrew).

Geraniaceae.

**Erodium Botrys*, Bertol. Common at Murray Bridge.

Linaceae.

Linum marginale, A. Cunn. Lameroo. Dwarf specimens, 5-15 cm. high, sometimes with only one stem and 1 or 2 flowers.

Rutaceae.

Microcybe pauciflora, Turcz. (Plate vii.) Port Lincoln; Yeelanna; Tooligie, E.P. The Tate Herbarium contains specimens from D'Estrées Bay and Mount Pleasant Station, K.I.; Southern Yorke Peninsula; while the Fl. Aust. gives "Lake Hamilton (Wilhelmi); Venus Bay (Warburton)." A dwarf shrub; leaves spreading, sessile or subsessile, 4-9 mm. long, tubercles inconspicuous; sepals oblanceolate, 1-1½ mm. long; petals bright yellow, 3-4 mm. long, glabrous or very rarely with a few hairs on the lower margin; filaments villous with stellate hairs on the lower part. The statement by Mueller (Fragm., i., 106) and by Bentham (Fl. Aust., i., 346) that the filaments are glabrous or villous is probably due to the fact that the 5 petaline filaments have in some flowers fewer hairs than the sepaline filaments, and sometimes are almost or quite glabrous. Professor Ewart has kindly allowed me to examine two Western Australian specimens from the Victorian National Herbarium—a co-type (Drummond, No. 209) and one from East Mount Barren (G. Maxwell). These specimens agree perfectly with ours, but, as they are more than half a

century old, all colour has faded from the petals. Diels and Pritzel (Fragm. phyt. Aust. occ. 324) say the flowers are white, and if this observation is correct, there must be a white-flowered form in Western Australia.

M. multiflora, Turcz. (*Eriostemon capitatus*, var. *baccharoides*, F. v. M.) (Plate vii.) Pinnaroo; Sedan (Rothe); Eucla (J. Forrest and J. D. Batt); Hoyleton (S. Dixon in Tate Herbarium); Fowler Bay and Gawler Ranges (D. Sullivan, *teste* F. v. M., Fragm., ix., 107). Leaves spreading-erect or erect and appressed, 2-4 mm. long, oblong or somewhat dilated and cordate at base, subpeltately attached to the branch by an excavation at the base of the upper surface of the leaf, the glandular tubercles conspicuous; sepals broader, more conspicuous, and villous than in the preceding; petals white, 3-4 mm. long, glabrous or ciliate with long hairs in the lower half; filaments glabrous; seed black, slightly wrinkled longitudinally. I have had an opportunity of examining a co-type (Drummond, No. 211) from the Victorian National Herbarium, from which I also received the Eucla and Sedan specimens. This small erect shrub is very common in the scrub bordering on the 90-mile Desert, south of Pinnaroo. Both these species of *Microcybe* occur at Murrayville, Vict., just across our border (H. B. Williamson).

Eriostemon difformis, A. Cunn. Mount Patawurta, near Moolooloo (Dist. S; E. H. Ising).

Phebalium bullatum, J. M. Black. This slénder shrub, which at Karoonda is rarely above 50 cm. high, grows to over 1 m. in the scrub south of Lameroo and Pinnaroo.

Boronia coerulescens, F. v. M. Both the glabrous and pubescent forms of this small shrub occur in the scrub south of Lameroo. The pubescent form has pale-purple flowers, while those of the glabrous plant are bright purple.

Tremandraceae.

Tetratheca pilosa, Labill. Scott Creek; Norton Summit; Blackwood; Brown Hill Creek; Bridgewater; Teatree Gully; Myponga; Victor Harbour. Plant hairy to almost glabrous; sepals dark red; petals varying from white to dark purple; leaves mostly scattered.

Euphorbiaceae.

Beyeria opaca, F. v. M., var. *linearis*, Benth. Pinnaroo.

Stackhousiaceae.

Stackhousia monogyna, Labill. Owienagin Gap, near Moolooloo (Dist. S; E. H. Ising).

Sapindaceae.

Dodonaea hexandra, F. v. M. Sherlock; Lameroo; Pinnaroo (Dist. M); Yumali (Dist. T; S. A. White).

D. cuneata, Rudge. Pinnaroo. A low shrub, not previously recorded for South Australia, although quoted for the "River Murray, Victoria," by Bentham in the Fl. Aust. It was included by Mueller in *D. viscosa*, but its short, almost truncate, subsinuate, mucronate leaves give it a very distinct appearance.

D. attenuata, A. Cunn., var. *linearis*, Benth. Mount Patawurta, near Moolooloo (E. H. Ising). Leaves only 1-1½ mm. broad.

Rhamnaceae.

Spyridium phlebophyllum, F. v. M. Mount Patawurta, near Moolooloo (E. H. Ising). This is the third and most northerly site where this plant has been found. The leaves vary in length from 5 to 15 mm.

Pomaderris racemosa, Hook. Yumali (Dist. T; S. A. White).

Sterculiaceae.

Lasiopetalum Behri, F. v. M. Yumali (Dist. T; S. A. White).

Dilleniaceae.

Hibbertia virgata, R. Br., nov. var. *incana*. *Variat foliis incanis cylindricis margine involutis, petalis parvis calycem aequantibus, carpellis 2-4-ovulatis.*

Karoonda; Pinnaroo; Yumali. The hoary cylindrical leaves, sometimes clustered, and the inconspicuous petals give this plant a very different appearance from the type, but it has the sepals, the broad floral bracts, and the stamens of the latter. It seems to be confined to the Trans-Murray scrub. The leaves are much like those of *H. fasciculata*, R. Br., var. *crassifolia*, Benth. (apparently rare, as I have it only from the Pinery, near Plympton, and along the railway from Woodville to the Grange), but they are usually alternate. The petals of var. *crassifolia* are deeply notched and the bracts are only reduced leaves, whereas the petals of *H. virgata*, var. *incana*, are merely emarginate, and the bracts are broad and scarious, like the sepals, and half their length.

H. stricta, R. Br., var. *canescens*, Benth. Mount Patawurta, near Moolooloo (Dist. S; E. H. Ising). Leaves and calyx softly stellate-pubescent; sepals 8 mm. long; carpels 6-ovulate.

Thymelaeaceae.

Pimelea Williamsonii, *nov. sp. (tab. vi.). Fruticulus totus sericeo-villosus circiter 20 cm. altus, ramis erectis vel ascendentibus, foliis alternis confertis subimbricatis oblongo-lanceolatis planis 10-15 mm. longis, floribus bisexualibus, spicis pedunculatis ramulos terminantibus primum ovoideis compactis et foliis supremis obtectis sed non involucratis demum usque ad 7 cm. elongatis, perianthio 4-5 mm. longo post anthesin circumscisso, parte inferiore fructiferâ 3 mm. longâ pilis longis erecto-patentibus occultâ, fructu obtuso valde ventricoso, exocarpio subherbaceo, endocarpio tenerrimo, testâ seminis crustaceâ atrâ sub lente punctulatâ apice uncinatâ, endopleurâ membranaceâ.*

South Australia.—Parilla (W. Gill Herbarium).

Victoria.—Murrayville (H. B. Williamson).

This species is named after Mr. H. B. Williamson, the well-known Victorian botanist and collector, who discovered it at Murrayville, 15 miles east of Pinnaroo, in 1917, and drew my attention to it when he was on a visit to Adelaide. It is distinguished from *P. sericostachya*, F. v. M., and *P. trichostachya*, Lindl., by its shrubby character and denser clothing of hairs, its broader leaves, which are crowded so as to appear somewhat imbricate, instead of distant, as in the two species named. It differs also in the smaller fruit, obtuse and ventricose almost from the summit, instead of gradually swollen towards the base, and in the hooked and smoother testa. The perianth of *sericostachya* is appressed-pubescent, while that of *Williamsonii* is covered by long, spreading-erect hairs. The method here employed of describing the fruit and seed is not that of the Flora Australiensis, but accords with the later view adopted by Bentham and Hooker in the Genera Plantarum, and by other recent botanists who have dealt with thus genus.

P. petrophila, F. v. M. Mount Patawurta (E. H. Ising). Leaves 10-15 mm. long, drying blue, as in some specimens of *P. flava*; flowers white, all female in my specimen. In the Tate Herbarium is a specimen from Wirrabara with leaves 15-25 mm. long, and male and female flowers in the same head. The only difference between this species and *P. flava* is that the leaves of the former are lanceolate-oblong, mostly acute and rather longer, while the involucral bracts are of the same shape as the leaves and considerably surpass the flowers. The distinction that in *P. flava* the perianth-tube does not extend above the ovary, while in *P. petrophila* it does so extend, is illusory. Both in the yellow-flowered typical form of *P. flava*, found in the Eastern States, and in the var. *diosmifolia*, the tube extends 1-1½ mm. above the ovary

and is readily circumsciss about half-way between the ovary and the perianth-lobes; in the ripe flower it is circumciss just above the fruit.

P. flava, R. Br., var. *diosmifolia*, Meissn. (*P. dichotoma*, Schlecht. in Linnaea, xx., 581, ann. 1847; *P. diosmifolia*, A. Cunn. Herb. ex DC. Prodr., xiv., 510, ann. 1856-57). Apparently the only form in South Australia. It is a low shrub growing round our coasts and as far inland as Teatree Gully, Modbury, Myponga, Lameroo, and Yumali. It differs from the type in its white flowers; leaves thicker, more rigid, usually smaller, and sometimes almost orbicular, with only 2 or 3 obscure nerves on each side of the midrib. The flowers are not always strictly dioecious; on some plants, which are chiefly male, 1 or 2 female flowers may be found among the males in each head. If *P. petrophila* is retained as a species, it would be more consistent if var. *diosmifolia* were also raised to specific rank as *P. dichotoma*.

P. microcephala, R. Br. There appears to be a certain amount of dimorphism about the fruit of this species. The drupe has always a more or less succulent pericarp, but sometimes this becomes red and berry-like, while other fruits on the same plant remain green and much smaller, although ripening the seed. The short female perianth becomes membranous and divides somewhat irregularly near the middle, the lower part often remaining attached to the base of the fruit for a long time.

Myrtaceae.

Eucalyptus diversifolia, Bonpl. Yumali (Dist. T; S. A. White). In scrub south of Lameroo. Here a small mallee; leaves rather broad and very thick, resembling those of *E. capitellata*.

E. incrassata, Labill., var. *dumosa*, Maid. Pinnaroo; Lameroo; Mulgundawa; Wellington. A small mallee, 3-5 m. high, with white bark except near the base, from which the dark bark often peels off. Fruit ovoid-oblong or ovoid, 8-9 mm. long, when ripe glossy, the valves sunk but the tips very slightly exserted. Cold-and-Wet Station (west of Coonalpyn; H. W. Andrew); A good-sized tree; operculum reddish and ribbed.

E. oleosa, F. v. M. Just south of the town of Pinnaroo this mallee is 5-7 m. high, with greyish-white bark on the upper part of the stem and dark bark peeling off at the base. Rocky slopes of Mount Patawurta, near Moolooloo (E. H. Ising). "A mallee with several clustered stems, 4-5 m. high, bark peeling off in strips up to 2 m. from the ground." In the stunted scrub south of Pinnaroo grows what appears to be a dwarf form of *E. oleosa*, tending towards *E. uncinata*,

Turcz. It is a small shrub, 1-2 m. high, with lanceolate, or linear-lanceolate, bright-green leaves, the operculum only 4 mm. long, but longer than the calyx-tube; fruit about 4 mm. long by 5 mm. diameter; valves 3, much exserted. Locally called "Green mallee."

E. calycogona, Turcz. Pinnaroo. In the better soil near this town this is a mallee 5-10 m. high, with fruits often 12 mm. long on unusually long pedicels of 6-7 mm. In some cases trees which have been cut down show butts 50-60 cm. in diameter, from which a number of stems spring. The inner bark is smooth and pale grey; the outer bark brown, rough, and peeling. In many instances specimens of *Fusanus acuminatus* ("Native Peach") were growing—probably parasitically—so close to these trees that the stem of the *Fusanus* was impressed into that of the *Eucalyptus*, forming a deep channel along one side. Further south, at the beginning of the 90-mile Desert, *E. calycogona* flowers as a whip-stick mallee not 3 m. high.

E. Morrisii, R. T. Baker in Proc. Linn. Soc. N.S. Wales, xxv., 312 (1900). Mount Patawurta, near Moolooloo; in bud and with fruits ripe and unripe, October 2, 1918 (E. H. Ising). First record in South Australia of this species, which has hitherto been found only on the western plains of New South Wales. The determination is by Mr. J. H. Maiden. Buds obovoid, the obtuse operculum slightly longer than the tube; fruits varying in size, the largest 10 mm. long by 9 mm. diameter, rim broad, at first flat, then conspicuously domed; leaves whitish, showing a similarity to those of the allied species *E. dealbata*, A. Cunn.

E. viminalis, Labill. Ferguson Gorge, near Moolooloo (Dist. S; E. H. Ising).

Micromyrtus ciliata, (Sm.) combin. nov. (*Imbricaria ciliata*, Sm. in Trans. Linn. Soc., iii., 259, ann. 1797; *Baeckea microphylla*, Sieb. in Spreng. Syst. cur. post. 149, ann. 1827; *Micromyrtus microphylla*, Benth., Fl. Aust., iii., 65, ann. 1866; *Thryptomene ciliata*, F. v. M. in Woolls, Pl. neighb. Syd. 23, ann. 1880). A slender erect shrub, common in the scrub south of Pinnaroo, about 50 cm. high; petals and calyx-lobes light pink. Under the lens the ciliation of the upper leaves is conspicuous.

Halorrhagidaceae.

Halorrhagis elata, A. Cunn. Mount Patawurta and Owienagin Gap, near Moolooloo (Dist. S; E. H. Ising). Small specimens, 15-20 cm. high. Blackheath, near Harrogate (H. W. Andrew).

H. heterophylla, Brongn., var. *glaucifolia*, Schindl. Marree (Hergott); Hawker.

Myriophyllum verrucosum, Lindl. Swampy ground in Monbulla scrub (Dist. T; H. W. Andrew).

Umbelliferae.

**Bupleurum semicompositum*, L. Common on the plain at Tailem Bend.

Epacridaceae.

Leucopogon virgatus, R. Br. Monbulla scrub, S.E. (H. W. Andrew).

Astroloma humifusum, R. Br. "Native Cranberry," Mount Patawurta, near Moolooloo (Dist. S; E. H. Ising). This is much further north than any previous record of the species, but it is a mountainous district.

Asclepiadaceae.

**Gomphocarpus fruticosus*, R. Br. Near Rendelsham, S.E. (H. W. Andrew). The specimens differ from those found near Adelaide in the almost oblong, apiculate follicle and the shorter, more erect segments of the corona, like those of *G. physocarpus*, E. Mey. They agree closely with a form described by N. E. Brown in the Flora Capensis, where he says, "Specimens with ovoid or ellipsoid, shortly and acutely pointed follicles are probably of hybrid origin between this species *(G. fruticosus)* and *G. physocarpus*."

Labiatae.

Westringia Dampieri, R. Br. Lameroo and Pinnaroo. In some specimens all the lower leaves are in 4's, the upper ones in 3's or 4's; in others, quite similar in appearance, all, or nearly all, the leaves are in 3's; leaves 7-15 mm. long; flowers light purple. There seems no doubt that *W. Dampieri* and *W. rigida*, R. Br., should be treated as one species; they cannot be distinguished by the leaves in whorls of 3 or 4. The form with very short, spreading, rigid leaves (3-5 mm. long), also occurs at Lameroo and Pinnaroo, and is found in many parts of the State from Renmark to Ooldea, and at least as far north as Moolooloo. This might be known as var. *rigida*, as it is evidently the form indicated in Brown's description.

Solanaceae.

Solanum simile, F. v. M. Yumali (Dist. T; S. A. White).

Scrophulariaceae.

Euphrasia collina, R. Br. *(E. Brownii*, F. v. M.) Lameroo (Dist. M). Flowers pale lilac.

**Veronica Tournefortii*, C. C. Gmel. Deserted gardens at Yallum, S.E. (H. W. Andrew), but apparently not established. Recorded as a "widely-spread weed" in Victoria by Prof. Ewart (as *V. Buxbaumii*, Ten.). A native of Middle and Southern Eurpoe.

Myoporaceae.

Eremophila neglecta, J. M. Black. O'Halloran Mount, near Oodnadatta; flowering July 7, 1918 (W. A. Cannon).

Goodeniaceae.

Goodenia vernicosa, *nov. sp. (tab. vii.). Suffrutex erectus glaber viscosissimus et quasi vernicio illitus circiter semimetralis, foliis anguste vel late lanceolatis in petiolo attenuatis rigidis serratis 15-25 mm. longis, supremis linearibus integris, pedunculis axillaribus 1-4-floris folio aequilongis vel brevioribus, pedicellis brevibus (2-3 mm. longis) supra medium articulatis basi bibracteolatis, calyce cylindrico costato 12 mm. longo, lobis linearibus tubum subaequantibus, corollâ flavâ 15 cm. longâ, lobis extus et tubo intus puberulis, stylo villoso, indusio basi barbato, capsulae oblongo-ovoideae septo apicem illius fere attingente, seminibus circiter 12 biseriatis crasse marginatis.*

Mount Patawurta, near Moolooloo (E. H. Ising). A similar specimen is in the Tate Herbarium, without locality or name of collector, and has been placed under *G. ovata*, Sm. It differs from that species in the narrower, rigid leaves and the ovoid capsule; from *G. varia*, R. Br., in the shape of the leaves; and from both in the thick viscid covering which gives the plant a varnished appearance, in the pubescent corolla, the villous style and the uppermost leaves of the inflorescence linear and bract-like.

G. Nicholsonii, F. v. M. Moolooloo (E. H. Ising). First record of this species for South Australia; it has previously been recorded for the Northern Territory. The flowers have all dried white, so that their colour may form another distinction between this species and *G. grandiflora*, Sims.

G. albiflora, Schlecht. Moolooloo (Dist. S; E. H. Ising).

G. pusilliflora, F. v. M. Pinnaroo (Dist. M).

G. humilis, R. Br. Kybybolite (Dist. T; H. W. Andrew).

Compositae.

Helichrysum obtusifolium, Sond. et F. v. M. Yumali (Dist. T; S. A. White); scrub south of Lameroo (Dist. M).

H. leucopsidium, DC. Pinnaroo (Dist. M).

H. semipapposum, DC.. Mount Patawurta, near Moolooloo (Dist. S; E. H. Ising).

Helipterum Jessenii, F. v. M. Pinnaroo.

H. corymbiflorum, Schlecht. Ferguson Gorge (E. H. Ising). Stems only about 15 cm. high and 1-headed by abortion.

H. dimorpholepis, Benth. Ferguson Gorge, near Moolooloo (Dist. S; E. H. Ising).

Calotis scapigera, Hook. Port Adelaide River; Murray Bridge; Renmark. Ray pink, turning white.

Ixodia achilleoides, R. Br. Coonalpyn (Dist. T; H. W. Andrew).

Olearia pimeleoides, var. *minor*, Benth. Yumali (S. A. White); Milang Road (E. C. Black); Dublin scrub (H. Griffith); Pinnaroo. A shrub 1-2 m. high; involucre 6 mm. long, at first cylindrical; ray-flowers, 6-10; disk-flowers about 10; achenes glabrous, when ripe cylindrical, black, ribbed, 2½ mm. long. In view of the smaller heads and leaves, the fewer flowers, and especially the glabrous achenes (not mentioned by Bentham), one feels a doubt as to whether this variety is not really a separate species.

O. Muelleri, Benth. Mount Patawurta, near Moolooloo (Dist. S; E. H. Ising).

O. ciliata, F. v. M. Lameroo; Karoonda (Dist. M).

O. lepidophylla, Benth. Loxton (Dist. M; S. A. White); Coonalpyn (H. W. Andrew); Alberton. Ray-flowers 4-6, disk-flowers 5-12.

O. floribunda, (Hook. f.) Benth. Loxton (S. A White); Coonalpyn (H. W. Andrew). Heads numerous, apparently in dense panicles; involucre 3-4 mm. long; flowers usually 6, 3 ligulate and 3 central; leaves clustered, 1-1½ mm. long; branches slender and flexible.

Brachycome exilis, Sond. Owienagin Gap, near Moolooloo (Dist. S; E. H. Ising). A minute form with simple stem, 20-35 mm. high in our specimens; all the leaves linear-cuneate and entire; ray-flowers pink, 5-9; disk-flowers only 2 or 3. I have similarly minute specimens from Tintinara, with entire leaves, but the stems are at least once-branched and the disk-flowers rather more numerous.

B. calocarpa, F. v. M. Lameroo. These specimens present a different appearance from the ordinary form, the whole plant being more or less woolly, especially towards the

base, the leaves very narrow, the lower ones 7-8 cm. long, with about 3 lanceolate lobes at the summit, or pinnatisect with a few linear or lanceolate segments, as well as the terminal lobes, the upper leaves entire or with 2 narrow lobes near the base; ray pale lilac. Prof. Ewart informs me that our plant agrees with specimens of *B. calocarpa* collected near the Murray River by Dallachy, as mentioned in the Fl. Aust.

Humea pholidota (F. v. M.), combin. nov. (*Ozothamnus pholidotus* vel *Cassinia pholidota*, F. v. M., Fragm. ii., 131 (1861); *Helichrysum pholidotum*, F. v. M., ex Benth., Fl. Aust. iii., 634 (1866); *H. squamata*, F. v. M., Fragm. xi., 86 (1880). Near Loxton (S. A. White); Karoonda; Lameroo; Pinnaroo. An erect shrub about 1 m. high.

Microseris scapigera, (Forst.) Sch. Bip. (*M. Forsteri*, Hook. f.). Lameroo. Leaves very narrow with linear-lanceolate lobes about 12 mm. long. Owienagin Gap and Ferguson Gorge (Dist. S; E. H. Ising).

Millotia Kempei, F. v. M. in Wing's South. Sci. Rec. ii., 2 (1882); var. *Helmsii*, F. v. M. et Tate in Trans. Roy. Soc. S. Austr., xvi., 368 (1896). The description of this species and a comparison with specimens in the Tate Herbarium show that it is the same as *Toxanthus Whitei*, J. M. Black in Trans. Roy. Soc. S. Austr., xxxix., 840, t. 69 (1915). This plant stands about half-way between *Millotia* and *Toxanthus*. It has the more numerous involucral bracts, the more numerous and larger flowers of *Millotia*, but it has the absence of pappus and the achenes obtruncate and slightly swollen at the base, which are characteristic of *Toxanthus*. In the endeavour to find a determining factor, I examined carefully the style-branches of *M. Kempei*, and found that they terminated, above the stigmatic streaks, in the short swollen cones of *Millotia*, rather than in the lanceolate papillose tips of *Toxanthus*. Baron v. Mueller's classification therefore appears to be the preferable one. In addition to Helms' specimens from near the Birksgate Range, the Tate Herbarium contains others from Ooldea and the Great Victoria Desert, W.A.

Erechthites prenanthoides, DC. (plate viii.). This plant grew in my garden at North Adelaide from seed which must have been buried in the soil of other plants brought from Mount Gambier. It lasted about one year. The female flowers numbered 10-12, the bisexual ones 5-8.

Cassinia laevis, R. Br. Between Coonalpyn and Cold-and-Wet (Dist. T; H. W. Andrew). Young leaves wrinkled above, but glabrous; flowers in head 4-5.

**Anacyclus radiatus*, Lois. This Mediterranean weed, with large yellow flowers, not previously recorded, was found growing on a dump at Port Adelaide (October, 1918; H. W. Andrew).

**Leontodon hispidus*, L. Near Lobethal (H. W. Andrew). Common; the forms with glabrous and hairy involucres both present. Already recorded for the South-East.

DESCRIPTION OF PLATES.

Plate VI.

Kochia Cannonii, n. sp. 1, leaf (side view). 2, leaf (seen from above). 3, fruit (seen from above). 4, fruit (vertical section).

Pimelea Williamsonii, n. sp. 5, flower. 6, upper part of perianth spread open. 7, pistil. 8, fruit, showing exocarp. 9, fruit after removal of exocarp, showing the delicate, transparent endocarp covering the testa. 10, seed. 11, embryo. 12, transverse section of fruit: *a*, exocarp; *b*, endocarp; *c*, crustaceous testa; *d*, membranous inner seed-coat (endopleura); *e*, albumen; *f*, cotyledons.

Plate VII.

Goodenia vernicosa, n. sp. 1, bud. 2, style and indusium. 3, vertical section of fruit. 4, corolla spread open.

Microcybe pauciflora, Turcz. 5, pistil. 6, one-half of flower spread open. 7, flower.

M. multiflora, Turcz. 8, one-half of flower spread open. 9, leaf (upper face). 10, leaf (lower face). 11, fruit: *a*, wrinkled coccus; *b*, cartilaginous endocarp; *c*, seed.

Plate VIII.

Erechthites prenanthoides, DC. 1, flower-head in bud and flower. 2, achene and pappus. 3, transverse section of achene. 4, stamens. 5, style-branches. 6, pollen-grain. 7, bisexual flower. 8, female flower.

Geological Memoranda (First Contribution).

By Professor Walter Howchin.

Subjects:

I. The "Sarsen" Stones of South Australia.
II. Pumice and other Substances occurring as Sea-drift near Cape Banks.
III. Salt, a Cause of Mechanical Disintegration of Rocks in Arid Regions.
IV. Nodular Barytes of Peculiar Forms from Central Australia.

[Read June 12, 1919.]

Plate IX.

I. The "Sarsen" Stones of South Australia.

Scattered over many of the southern counties of England are large blocks of hard siliceous sandstone, usually oblong in shape, several feet in thickness, and up to 10 ft. or 15 ft. in length, that for centuries have been a great puzzle to the rural population. The stones are foreign to the rocks of the neighbourhoods where they occur, and appeared to the country people as though dropped promiscuously over the landscape. The name by which they are generally known is that of "sarsen," or "sarsden" stones, which is supposed to be a colloquial abbreviation of the word Saracen, a survival from the time when the name of the Moors, or Saracens, was one of superstitious terror in southern and western Europe.(1) As these stones are often seen in groups, and at a distance have the appearance of sheep lying down in the grass, they are commonly called "grey-wethers." Further, these large, slab-like shafts were eminently adapted for use in the erection of monoliths and the building of tumuli and open-air temples of the prehistoric peoples, and from their being frequently utilized for such purposes they have also obtained the name of "Druid stones." The outermost circle of great stones, as well as the second circle, at Stonehenge is constructed of sarsen stones; indeed, there was no other geological formation in the country that yielded stones anything like so great a size.

(1) Other explanations have been given as to the origin of the word. *Sarsen* is said to be a Phoenician word, meaning a stone, and may have been a survival from the time when these navigators visited England. "The early Christian Saxons used the word *Saresyn* as a synonym of pagan or heathen."—Dr. Brewer. "A corruption of a Celtic word."—Chambers' Encyclopaedia.

These mysterious stones have attracted the greater attention because of their occurrence in parts of the country where there are no hard rocks, and they therefore possess an economic value, being used for road metal, gate posts, farm buildings, paving, etc., which has led to the destruction of many megalithic monuments. Camden complained of the vandalism that was rampant in his day in destroying such interesting archaeological structures for utilitarian purposes. He says,(2) "Above the head of the River Ock, by Ashbury-park, is a camp of a figure as near round as square, the diameter above an hundred paces and the works single, but the works are now almost quite spoiled and defaced by digging for the sarsden stones as they call them) to build a house in the park belonging to the Lord Craven."

A few years ago a public movement was inaugurated in England, and an appeal for funds was made, commended and financially supported by the Geological Society of London, for the preservation of the grey-wethers of Marlborough Downs. Our Honorary Fellow, Mr. Edward Meyrick, B.A., F.R.S., was one of a committee of gentlemen formed for this object, and at my request sent out some fragments broken from sarsen stones for comparison with our local examples.

The subject has given rise to a somewhat extensive literature, and references will be found to these objects in most county histories (where they occur), geological textbooks, encyclopaedias, dictionaries, and newspaper correspondence.(3)

Many conflicting theories have been advanced to account for the origin and distribution of the sarsen stones, but it is now generally agreed that they form the remnants of what was once an extensive geological formation (or formations) of Tertiary Age that covered a considerable portion of southern England. The beds consisted of sands and fine gravels (probably of different geological ages), the greater portion of which remained unconsolidated and has been removed by denudation, but in places a lcoal silicification took place which converted more or less of these sediments into very hard siliceous rocks, that have resisted weathering and have been preserved in the form of isolated boulders or slabs of rock. This gives us the distinctive features of a sarsen stone—a partial silicification has

(2) "Britannia," 2nd ed. (1722), col. 162.

(3) The following might be consulted:—H. B. Woodward: "Geology of England and Wales," 1876, p. 363; W. Whitaker: "Age of the Grey-wethers," Jour. Geol. Soc. of London, v. 18 (1862), p. 271; E. C. Spicer: "Sarsen Stones in a Clay Pit," *ibid.*, v. 61 (1905), p. 39; A. C. Ramsay: "Physical Geology and Geography of Great Britain," 1872, p. 126; H. W. Monckton: "Notes on the Sarsen Stones of the Bagshot District," Report Brit. Assoc. Adv. Science (Southport), 1903, p. 669

taken place by the infiltration of silicated waters into an open and porous rock, causing great induration within certain limits, and such indurated portions have persisted, whilst the incoherent portions of the beds have become washed away.

As the sarsen type of stone depends on the petrological texture of the stone and its mode of distribution, rather than the geological age of the rock, they may occur in any country and of any age when the suitable conditions for their formation exist. Sarsen stones of this type are widely distributed throughout South Australia. They have not attracted the same attention from the public here as those of England, from the fact that in England they are rendered conspicuous because they occur in districts where few other hard stones are found, while in South Australia they occur in places where they are surrounded by outcrops of hard rocks, and in many cases the two classes of rocks are so similar in appearance that only an experienced field geologist can detect the difference.

In South Australia sarsens are found along the lines of ancient drainage, where the sands and gravels of rivers that no longer occupy these valleys have become intermittently subjected to silicification, having some portions altered to a close, compact, siliceous rock, while other portions have remained loose and friable, or entirely removed by denudation. They often form groups in the paddocks, preventing cultivation, or occur as large boulders overspreading some ancient terrace, like the grey-wethers of southern England. They can be seen from the railway train near Yacka, and at Stone Hut, and in many positions on the Willochra Plains between Melrose and Booleroo Centre, also on the low range facing the sea near Ardrossan,(4) and in many other situations.

The English sarsen stones are of a light-grey colour, and in most cases are very fine in the grain, possessing a saccharoidal lustre. Examined in thin sections by the microscope, they are seen to consist almost exclusively of very fine sand grains, closely dovetailed and united together by a siliceous cement. On account of this form of structure they exhibit a conchoidal fracture.

The South Australian examples answer generally to the same descriptions. In most cases a different form of silicification can be recognized between that of the siliceous quartzites of Cambrian Age and the siliceously-cemented river sediments that have made the sarsen stones. The Cambrian quartzites give evidence of metamorphic action, while the indurated river sediments do not. In the case of the metamorphic

(4) Howchin: "Notes on the Geology of Ardrossan and Neighbourhood," Trans. Roy. Soc. S. Austr., v. 42, 1918, pls. xxii. to xxvii.

quartzites the siliceous cement has absorbed the original grains of sand, which cannot always be clearly distinguished from the cement that has blended them all together. In the case of the sarsen stone, the cement, whilst intensely siliceous, is distinct from the granular constituents of the rock.

Another point of difference between the two classes of rock is that whilst the Cambrian rock is regularly bedded, possessing a rough surface, and tends to split along the bedding planes, the sarsen stone is generally more or less spheroidal, or irregular in outline, and generally possesses a smooth and glazed surface. It is the finer-textured rocks that exhibit the more complete silicification, as in the case of sands and fine gravel; the coarser gravels are frequently strongly cemented, but they do not show the same clean fracture as is seen in the finer-grained examples.

II. Pumice and other Substances found as Sea-drift near Cape Banks.

I am indebted to Mr. G. A. Payne, late Head Keeper at Cape Banks Lighthouse, for a number of interesting objects that he has collected from the beach in that locality. The more interesting of these comprise pumice, scoriaceous lava, torbanite, asphaltum, and native resin.

pumice.

Mr. Payne states that he has collected from the beach three examples of this rock. He says that "two were about the size of a small loaf of bread and the other the size of two loaves." The latter specimen was kindly donated by Mr. Payne to the University Museum. It is slightly water-worn and, roughly, pear-shaped. It measures 13 in. in length and 20½ in. in transverse circumference. It is a characteristic example of its kind, greyish-white in colour, rough to the feel, open and vesicular in structure, with numerous large, elongated vesicular gas spaces. The central portion of a second specimen, also forwarded by Mr. Payne, has precisely the same features. The specimens in each case occurred on the southern side of Cape Banks, and were found high up among the sandhills, where, Mr. Payne thinks, they must have been buried for years.

The occurrence of drift-pumice in this locality was quite unexpected and is difficult to explain. Although the Millicent and Mount Gambier volcanic fields are not very distant from Cape Banks, no pumice is known to occur on either of these fields, and if there was, there is at present no running water that might account for their transportation to the coast. Neither is pumice known to occur along the

Victorian coast. Mr. Herman, the Director of the Geological Survey of Victoria, has courteously replied to my enquiries on this subject as follows: "I do not know, nor do any of my staff whom I have been able conveniently to consult, know of any pumice on the south coast of Victoria. I rang up Professor Skeats, who also does not know of any, neither do we know of any deposit *in situ* in Victoria which approaches the character of a true pumice."

Professor Liversidge[5] records pumice from New Guinea, New Britain, and from the Pacific, the last-named being examples washed up on the coast of New South Wales. He says, "Masses of pumice are frequently cast up on the beach along the coast of New South Wales, and at times are also found in the harbours, and they are not infrequently picked up within the Sydney Harbour.[6] The source of this pumice is, of course, a foreign one, and doubtless it is derived from more than one of the volcanic centres of the Pacific, but which of them does not as yet appear to be very clear. It is always water-worn, and at times more or less coated with *serpulae*, and has evidently been long in its travels across the sea. It is stated to be more abundant after an easterly gale, and is found more often on the north side of the inlets along the coast than in other situations; in size the pieces vary from quite small fragments to pieces 9 or 12 in. through. . . . It would be very interesting to trace the limits of the distribution of pumice along the Autralian coast, and I trust that someone will undertake this duty."

The following replies to some enquiries made by me have been received from Mr. Charles Hedley, of Sydney, who is intimately acquainted with the coast of New South Wales:—"Your note about the pumice is very interesting, and I hope that you will put it on record. On this coast, from Sydney to Jones Strait, pumice is very common. On the coral islands of The Barrier it may extend continuously along the beach, at high-tide level, in lumps the size of a cricket ball to a marble. The pieces you describe are unusually large. There is material in your pumice for some interesting deductions."

In the absence of any known local source from whence these pieces of pumice can have been derived, it is natural to think of them as having been sea-borne. But there are difficulties in readily accepting this explanation. The condition of the specimens does not suggest a long sea voyage. Whilst somewhat water-worn, they have not suffered that extent of

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(5) "The Minerals of New South Wales," etc., 1888, pp. 250, 255, 258.

(6) Professor David informs me that one piece washed up in Sydney Harbour measured 3 ft. in length.

erosion that might be expected to have occurred during a protracted sea journey. Moreover, the specimens submitted to me give no evidence of marine life that might have become parasitically attached to the floating pumice, such as algae growths, *Serpula*, or *Balanus*. Neither of these considerations are, however, fatal to the theory, as the amount of wear is dependent on contact with hard substances floating in the water or the amount of attrition suffered on the beach before the pumice-stone came to rest; and many of such sea-borne stones are found equally destitute of marine growths. So far, however, the negative evidence is in the direction of a short voyage or no voyage at all.

Again, the ocean currents that prevail along the southern coasts of Australia are not supposed to have a direction that would bring floating matter, by a direct path, from a region where pumice is supposed to occur. The Antarctic current, influenced by the strong westerly winds, takes a north-easterly direction, and becomes a wide-spread "drift"; one branch, going northward, follows the coast of Western Australia, and the other takes an easterly course along the southern shores of the continent.

Under date March 25, 1916, Mr. Payne writes: "With regard to currents, I have picked up quite a dozen bottles containing letters, memos., flags, etc., thrown overboard by our soldier boys, and quite a number have come from the Great Bight to a spot known as the 'drift,' or 'desert,' between Lake Bonney and the sea, about 2 or 3 miles north of Cape Banks, and north of where the 'Admella' was wrecked. The 'drift' is a great place for all kinds of wreckage, etc., from the sea." Also under date August 6, 1917, I received particulars from Mr. Payne of a "current paper" thrown overboard on September 26, 1916, in lat. 40° 17′ S., and long. 126° 58′ E. (south of the Great Bight), and was picked up 10 miles to the north of Cape Banks on July 26, 1917, the maximum time for the journey being fourteen months.

There is probably some reason why such unusual quantities of floating material should accumulate on the beach a few miles north of Cape Banks, and which has given the locality the name of the "drift." Some chartographers represent the great easterly drift, to the south of Australia, as bifurcating on the western side of Tasmania, one branch making a westerly turn, forming a large eddy to the south of the Great Bight, while another section, after hugging the western coast of Tasmania, passes eastward through Bass Strait. There is probably a neutral zone between the two currents, one going west and the other going east, and would

coincide with a geographical position very close to Cape Banks. The parting of the currents may well account for the quantity of debris cast up at the spot known as the "drift" mentioned by Mr. Payne.

The localities from which the pumice may have originated (judging from its known geographical occurrences) are New Zealand, the Pacific Islands, the Eastern Archipelago, or, possibly, a sumbarine volcano of unknown position. That pumice of the size found near Cape Banks should have been lost overboard by a passing ship is also not thought to be probable.

Mr. Hedley suggests that the specimens came from the Malay Archipelago, round the Leeuwin. The northerly drift on the western side of the continent is against this view, but it is not impossible for a floating object, starting, say, from the Sunda Strait, and being caught in the equatorial current, to make the round of the Indian Ocean, and, coming south, enter the west wind drift, and so reach the southern shores of Australia. But that is a very long journey, and if that were a source of pumice drift we might expect that it would be found on shores more to the westward than Cape Banks.[7]

It might again be suggested that a strong easterly wind blowing through Bass Strait for several days would probably have the effect of temporarily destroying the west wind drift, and by reversing the current bring in the drift from the Pacific through the Strait and as far westward as the southern limits of South Australia.

Ocean drifts that are dependent on prevailing winds vary with the winds. They may be weak or strong, shift their position, and even become for a time reversed, according to seasonal variations. Pumice is a common stone in New Zealand, and is likely to find its way at times to the sea. The Pacific current that comes down the eastern coast of Australia, and encircles the Tasman Sea, may possibly bring pumice to its southern limits where it makes its return bend. If under such circumstances a slight westerly drift sets in from the Tasman Sea, extending to the western side of Tasmania, any floating matter would then be brought within the range of the drift that follows the southern coasts of Australia, and might in this way become the carrier of pumice from the east.

The examples obtained from Cape Banks possess certain characteristics which should assist in their identification. The

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[7] After the above was written a public notice was given of a bottle, thrown overboard from a troopship at Colombo, having been picked up on the beach near Cape Jervis.—See *The Register*, June 10, 1919.

stones are exceptionally open in their texture. The gas spaces (over and above the usual small, elongated spaces which give pumice its characteristic features) are often large, measuring from 1 to 3½ in. in length and up to ½ to 1 in. in transverse diameter, giving the stone a particularly light and open appearance. These are useful features for comparison, and now that attention has been called to this subject, it is hoped that observers will be on the look out for further evidences that may be of interest bearing on this subject.

SCORIACEOUS LAVA.

The specimen forwarded to me by Mr. Payne is black-coloured, glassy, very open in texture, with numerous rounded gas vesicles, identical in appearance with the scoriaceous lava of Mount Gambier and Mount Schank. Mr. Payne picked up examples of this kind on the beach both on the northern and southern sides of Cape Banks, and states that "the largest piece was about the size of an ordinary loaf of bread." The sea has washed the bases of the volcanic vents in the neighbourhood of Millicent since these volcanoes were in eruption, but there is nothing to indicate that these scoriae were actually derived from this source. There are igneous rocks on the Victorian coast, a little beyond the South Australian border, and it is possible that the specimens may have come from that direction; if so, it would be a further evidence of an occasional westerly drift along the coast.

ASPHALTUM (BITUMEN).

This substance has a very wide distribution along the southern coast of Australia, extending from Tasmania on the one side to near Bunbury, in Western Australia, on the other. A typical specimen was included in the beach specimens forwarded by Mr. Payne. It is an angular fragment, 5 in. in long diameter, with the usual pitch-like lustre, and is in all respects similar to many others that have been noted and described, and frequently raised delusive hopes as to a local occurrence of mineral oil[8] in the vicinity where these fragments have been found. The specimens that have been obtained over this very wide area possess very uniform characteristics, which make it probable that they have had a common origin. Dr. Wade has said,[9] "I am firmly

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[8] See L. Keith Ward: "The Possibilities of the Discovery of Petroleum on Kangaroo Island and the Western Coast of Eyre Peninsula," Geol. Sur. S. Austr., Bull. No. 2, 1913, p. 13. Also Dr. Arthur Wade: "The Supposed Oil-bearing Areas of South Australia," Geol. Sur. S. Austr., Bull. No. 4, 1915, p. 33.

[9] *Loc. cit.*, p. 34.

convinced by the evidence that the material originates from beds now covered by the sea, beds thrown down by the great fault system known to exist, protected to some extent by the deep sea deposits, and lying south of the continental shelf. As a surmise, I should say that just as the great trough faults of the Dead Sea area have exuded bitumen in places, seen by myself, so the bitumen found on these coasts may be at present escaping from the similar fault planes mentioned."

Another suggestiton as to its origin may be ventured. The very wide distribution of this substance indicates that ocean currents must be concerned in its distribution, and the wide distribution also suggests that the source is relatively distant. The geology of Kerguelen Island is not well understood, but it is known that beds of Tertiary Age, including coals of poor quality, occur there.(10) It is a region that has been greatly disturbed during Tertiary times, and it is within the range of possibility that conditions may have arisen that were favourable for the distillation of the carbonaceous material into hydrocarbons in parts of this coalfield. Dr. Wade's bitumen-exuding faults may be situated near Kerguelen rather than the southern coast of Australia. It is further to be noted that Kerguelen is in the direct line of the west wind drift, the waters of which are carried up the Western Australian coast as well as along the southern coast of Australia and around the island of Tasmania. If the bitumen originated at Kerguelen the outcrops are probably submarine in position.

FOSSIL RESIN.

Two fragments of a fossil resin, broken from a larger mass, were included in the samples sent by Mr. Payne. The example is yellowish in colour and banded. It is rather remarkable that lumps of resin are frequently found on the coast where the pieces of asphaltum occur. At the Brecknell Sandhills, on the southern coast of Kangaroo Island, I found the two in association. Dr. Wade refers the resin to the species "retinite," a variety of copalite. These resins have no genital relationship to the mineral oils, but they may have had a similar geographical origin as that of the asphaltum waifs. If Kerguelen Island be the source, then we must assume that the resins have been derived from beds of carbonaceous material that have not undergone destructive distillation, whilst those that have yielded the bituminous product, we may assume, have been subjected to such a change.

(10) See Tate: "On the Occurrence of Marine Fossiliferous Rocks at Kerguelen Island," Trans. Roy. Soc. S. Austr., v. 24 (1900), p. 105.

TORBANITE (KEROSENE SHALE).

A fragment of this mineral (sawn by Mr. Payne from a larger portion) also formed a part of the collection from Cape Banks. It is brownish-black in colour, has a dull lustre, and burns freely when a lighted match is applied to it. It is identical with the mineral torbanite which is mined at Hartley and other places in New South Wales, where it is used for the production of mineral oil, and is also sometimes exported. There can be no doubt that the piece in question has come from some vessel trading along the coast, and which by some means had fallen overboard. The Government Geologist, Mr. L. Keith Ward, mentions two other instances in which the same mineral substance has been found on the South Australian coast; one of these was on the beach at The Frenchman, Eyre Peninsula, and the other at the head of the Great Bight.[11]

III. SALT A CAUSE OF MECHANICAL DISINTEGRATION OF ROCKS IN ARID REGIONS.

When visiting Stuart Creek pastoral station in 1904, by the kindness of Mr. W. Oliffe, the manager of the station, I was taken over some extensive opal deposits on the run. These were situated to the northward of Pidleeomina Waterhole, in the neighbourhood of Charlie's Swamp, about 30 miles to the south-eastward of the head station. The opal deposits occur in the upper portions of the cretaceous clays, and are distributed over a strip of country several square miles in extent. They occur usually as thin reticulating veins, or as cylindrical bodies, which in some examples reach a diameter of 12 in. The opal lacks "fire," and is therefore of the common variety, but some of the specimens are beautifully tinted, of various colours, and translucent, resembling the fancy jellies produced by culinary art.

A very fine example that was exhumed in my presence was in the form of a tree trunk, 2 feet in circumference, possessing some indication of woody structure. The outer portions are milk white, shading off to a delicate pink, and the centre consists of transparent opal of a saffron colour. A fair-sized segment of this opalized tree was secured and brought to Adelaide, but in a short time the greater portion of the specimen cracked and fell to pieces. A few of these splintered fragments were about an inch in diameter, but the greater part of the disintegrated opal consisted of an innumerable assemblage of small splinters. This intimate

(11) *Loc. cit.*, p. 21.

disintegration of a compact and apparently pure opal rock was an unexpected occurrence. On examination it was found that an efflorescence of salt covered all the planes of fracture, and this is suggestive of the cause of the disintegration. The effect of frozen water in disintegrating and fracturing absorbent bodies by expansion is well known. This property of expanding when passing from a state of solution to that of crystallization is characteristic of most solvent substances, and, in the case before us, it appears that a certain amount of salt solution was taken up by the opal at the time of its consolidation. Whilst the opal was buried in the soil it retained its quarry-water, or "sap-water," to use a quarryman's term, but when placed in the cabinet desiccation followed, the water evaporated, and the salt crystallized out, producing internal stresses that caused a general rupture of the mass.

This action is known to be operative in all dry regions where the surface waters are mostly mineral solutions and subjected to alternate conditions of imbibition and desiccation. What has occurred in the case of opal may be expected to occur also in most other rocks under similar conditions, especially those of an open texture, such as sandstones, shales, clays, etc., many examples of such chemico-mechanical disintegration were noted in the region referred to.

IV. Nodular Barytes of Peculiar Forms from Central Australia.

Barytes (barium sulphate), or "heavy spar," occurs in South Australia under a variety of forms. In Mitcham quartzite quarries it has been obtained in well-formed tabular orthorhombic crystals, and also of lamellar structure and translucent. In some parts of the Mount Lofty Ranges it occurs in veins with a granular crystallization, as in the barytes mine near Blumberg. It not infrequently forms the gangue in mineral lodes, as at the New Burra Copper Mine, south-east from Kooringa. It also occurs sporadically as nodules in limestones and clays. These nodular forms are interesting from the variety of shapes they assume. At the Brighton limestone quarries nodules of barytes are not at all uncommon. Some of these have mammillary forms, white to brownish in colour, columnar and radial in structure, with a smooth porcelain-like surface, and in some examples attain a large size. One such obtained by me from these quarries is hemispherical in shape, with the appearance as though a viscous liquid had been poured out of some vessel—weighs 14 lbs.

Certain kinds of clay beds develop these nodules of barytes. In the Permo-carboniferous glacial clay at Black Point, Hallett Cove, there is a layer in which a large number of barytes sand-crystals occur.(12) The crystals, which have incorporated sand grains in the process of crystallization, form clusters that have a lenticular or subglobular shape.

The clays of the interior of Australia in some cases carry nodules of barytes. The commonest form which these concretions take is that of a flattened cake, which has given them the colloquial name of "buns." Mr. F. R. George, of the Mines Department, obtained some of these baryte "buns" when leader of the Government North-West Prospecting Expedition in 1904. Mr. W. T. Chapman,(13) the assayer at the Adelaide School of Mines, who analyzed one of these nodules, states that "the specimens were obtained in the tablelands about 50 miles west of Coward Springs railway station, and occur as nodules somewhat resembling coprolites. Mr. George states that the nodules vary in weight from half an ounce up to about 3 lbs. They are of a grey colour. An analysis made by this department resulted as under:—

	Per cent.
Water	0·39
Silica	0·43
Alumina	1·92
Ferric oxide	0·56
Sulphuric acid	33·82
Baryta	62·00
Strontia	0·13
Lime	0·14
	99·39

I have recently received from Mr. George Warren, of Springfield, two examples of these "buns." They were obtained on the Anna Creek Run, about 60 miles to the south-westward of the head station. They are known to occur over an area of about 12 square miles, distributed over a flat, on the northern side of a ridge of low hills consisting of white clay-like rock, which is capped by a hard layer of desert sandstone. The specimens are in considerable numbers, and vary in size from a florin to a disk of 1 ft. in diameter.

Whilst on a visit to Stuart Creek cattle station, in the Lake Eyre district, in 1904, I came upon a white clay bank that was strewn with barytes nodules of quite a different shape from the "buns." They might be compared in appearance to a ball of stout cord that had been wound and intertwined upon itself. The thickness of the cord-like casts varies

(12) See Mawson: "Mineralogical Notes," Trans. Roy. Soc. S. Austr., v. 31, 1907, p. 119.

(13) Report School of Mines and Industries, 1904, pp. 73, 74.

in different specimens, but is uniform throughout in the case of each individual specimen. Mr. W. T. Chapman kindly undertook to make an analysis of one of these, with the following results:—

	Per cent.
Sulphur tri-oxide	32·67
Barium oxide	60·42
Calcium oxide	0·10
Strontium oxide	0·06
Alumina	2·78
Ferric oxide	0·34
Magnesia	0·08
Silica	3·24
Water	0·71
	100·40

It will be noted that the two analyses are closely similar; the most marked differences are in the slightly higher proportions of silica and alumina in the second instance, probably arising from a small amount of clay being incorporated with the barium sulphate in the nodules. They are non-crystalline and amorphous in texture.

These singular nodules are undoubtedly casts, and have taken their shape from the cavities in which they were formed. Their resemblance to coiled earthworms is very striking, and suggests their probable origin. When holes are dug in garden ground during a period of drought it is not unusual to find at a considerable depth earthworms coiled up within a little chamber in the dry earth. This chamber corresponds to the hibernaculum, or shelter, into which hibernating animals retreat during the winter, but in the case of the earthworm the deep-seated cavity gives protection, not from the frosts of winter, but from the heat and prolonged dryness of an Australian drought. Among the nodules collected by me were some that appear to be of an intermediate form between the annelid-like knob and the bun-like disks. Both kinds may have formed in cavities formerly occupied by annelids, the difference being that in some cases the cavity has preserved the true outline of the former occupant, while in others it has not.

The source from whence the barytes has been derived cannot at present be definitely determined. Barium salts are not infrequently found in saline waters, and the sulphates of barium and lime are often found in association, as occurs in the regions from which our specimens have been collected. In the case of the nodules, the baryta would probably form, in the first instance, a soluble bicarbonate, and then by a chemical reaction with some soluble sulphate be converted into barium

sulphate. Why the barytes should show a preferential selection of these empty annelid chambers, as is assumed in these notes, is not very apparent, except on the general principle that most minerals in solution show a tendency to undergo precipitation on reaching a cavity in the rocks.

DESCRIPTION OF PLATE IX.

Fig. 1. Cast of vermiform-like object, entwined. Slightly under natural size.

Fig. 2. Cast of, apparently, two objects of a similar kind, closely adjacent or intertwined with each other. Slightly under natural size.

Fig. 3. Cast of similar object, showing irregular twisting. Natural size.

Fig. 4. Cast in which the coils are more regularly arranged in a spiral form. Natural size.

Fig. 5. Another example, in which the coils are wound at right angles to each other. The specimen is a fragment showing fracture at both extremities. Natural size.

Fig. 6. In this specimen the coils are wound around a central axis in one plane, having a discoidal form. A head-like termination of the coil is seen at the upper margin. This example forms an intermediate type between the worm-like casts on the one hand and the discoidal "buns" on the other. Natural size.

Figs. 1, 4, 5, and 6 agree in the diameter of their respective coils; and figs. 2 and 3 also agree with each other in this respect, being somewhat smaller in diameter than the others mentioned. In the two examples shown in figs. 2 and 3, slight constrictions occur in the body whorls (especially where the latter make an acute turn), which may have been caused by a succession of small bulgings of an annulated soft body as the result of longitudinal pressure. This feature, while quite distinct in the objects, is not well shown by the photographs.

A Review of the Genus *Loricella* (Order Polyplacophora), with Notes on Features Previously Unnoted and Description of a New Species.

By Edwin Ashby, F.L.S., M.B.O.U.

[Read May 8, 1919.]

Plate X.

The only recorded species of the genus *Loricella* was described by H. Adams and Angas in P.Z.S., 1864, p. 193, under the name of *Lorica angasi*, but later Pilsbry, in Man. Con., pt. 56, p. 238, very wisely separates it from that genus, and proposes the generic name of *Loricella* for its reception, distinguishing it from the genus *Lorica* as follows: "Sinus in tail valve a mere wave; jugal sinus lobed; girdle widest in front, not cleft behind"; but adds the note, "I have not seen this species, which is here figured for the first time from drawings made by Emerton for Carpenter."

An examination of a fair series makes it necessary to modify this generic description. The sinus in the tail valve in most specimens is considerably more than "a mere wave," although certainly not as deep as in the genus *Lorica*, and Dr. Pilsbry is quite in error in stating that the girdle "is not cleft behind," for in all my specimens from New South Wales, Victoria, Tasmania, and South Australia the girdle is very distinctly cleft, though only for half the width of the girdle. The cleft in the girdle probably did not show clearly in the dried specimens that Carpenter was dealing with, and this fact somewhat misled Pilsbry. This cleft and the character of the tail valve show some affinity with the genus *Lorica*, but on the other hand the large head and small foot, together with its markedly distinct girdle suggest that this relationship may be more seeming than real.

I therefore propose that instead of treating it as a section or subgenus of *Lorica*, as is done by Dr. Pilsbry (Man. Con., pt. 56, p. 233), it should be elevated to full generic rank.

As Adams and Angas' type of *Loricella angasi* came from Rapid Bay, South Australia, that name will have to be retained for the South Australian species. It is remarkable that in the original description no mention is made of the row of long, branching, coarse hairs, or of the strange spear-headed spicules attached to them, which are a prominent feature on the girdle of the South Australian form, and which is described herein for the first time. The only explanation is that the type was a worn specimen that had been washed ashore.

Dr. H. A. Pilsbry, whom I had the pleasure of meeting in Philadelphia last year, on looking at my specimens, was much interested in this strange feature, and considered that it well justified the separation of the South Australian form from that found in the other States.

Owing to the imperfections of both figure and descriptions, it is necessary to append a full description. As far as I am aware, *Loricella angasi* has only been figured in Dr. Pilsbry's famous monograph on Polyplacophora, pl. 51, fig. 9, the drawings of which were made by Emerton, for Carpenter, Dr. Pilsbry having no specimens to examine. In that figure short hairs are shown on the anterior portion of the girdle, but Dr. Pilsbry appends a note, "The hairs shown in the girdle, in fig. 9, are foreign to it."

LORICELLA ANGASI, H. Adams and Angas.
(Proc. Zool. Soc., 1864, p. 193.)

General appearance.—Shell broad, carinated; when alive the whole of shell is usually covered with limy encrustations and growing algae; when these are cleaned off the lateral areas are seen to be strongly raised and covered with close wavy ribbing. The pleural areas, closely covered with longitudinal wavy riblets; girdle, broad, the anterior portion is double the width of the posterior and is crenulate at margin, but in adult specimens this crenulation in the anterior portion is produced in a number of flattened finger-like processes, up to 4 mm. in length, and extending beyond the margin of the girdle.

Colour.—The anterior valve and lateral areas are terracotta, with the exception of valve 2, in which the lateral area is the same colour as the pleural area; in the pleural and dorsal areas the lighter markings are dull white, tinged with olive, and the darker markings vary from brownish-olive to light-brownish-olive. The girdle, while for the most part olivaceous, the margins and various patches are rosaline-purple, but this may be due to a red alga. Inside of valves white.

Anterior valve.—Very large and broad, strongly convex in the middle, apex recurved, the whole valve covered with closely-packed wavy riblets. The posterior margin finely serrated. The inside has 8 slits nearly equidistant, teeth finely pectinated, and on the upper side fluted.

Posterior valve.—This is the smallest of the valves, the mucro terminal, and much elevated; the posterior half of this valve is recurved, diagonal ridges strongly raised, and the dorsal ridge well marked. The whole valve covered with wavy longitudinal ribbing, with transverse growth lines.

Central valves.—Lateral area strongly raised and sculptured with closely-packed wavy ridges similar to the anterior valve, broken at irregular intervals by deep sulci following

the growth lines; also in some of the valves the ribbing shows a subpustulose tendency; the posterior margin is finely serrated. Pleural area and dorsal area covered with closely-packed wavy longitudinal ribbing, which is decussated or bridged in the dorsal area and partly in the pleural area; eaves prominent; insertion plates fluted on upper side and very strongly toothed with sharp saw-like teeth; sutural laminae much produced; sinus broad and lobed.

Girdle.—In dried specimen 8 mm. wide in front, or without the flattened appendages, 5 mm. in front and half that width behind, cleft for half its width at tail, very closely beset with solid, irregular, minute scales. But the most marked feature is a large number of coarse, branching, brown hairs or spicules up to 4 mm. in length, placed in an irregular double row, spaced from 2 to 3 mm. apart in the anterior half, but hardly present in the posterior half. Each branch of these hairs has an ovate, spindle-shaped terminal, reminding one of a white stiletto, but they are too broad to be described by that term, and may be better described as sharply-pointed white cylinders or spear-heads, which are at their base twice the thickness of the hair to which they are attached. These strange white spicules are clustered thickly at the base of and along the centres of the flattened finger-like processes, before referred to; these are sessile, rising straight out of the girdle. There seems to be some relation between these spicules and the protruding portions of the girdle, as they and the hairs to which they are attached are only present opposite these. There are a few scattered about the girdle not in the main double row.

Measurements.—The specimen described in the foregoing is 67 × 41 mm. Another, taken at the same time, now in Mr. May's collection, measures 68 × 47 mm.; and one I found washed up on the beach at Aldinga Bay is 68 × 48 mm. When alive the girdle would add somewhat to the foregoing measurements.

Habitat.—I first took this shell alive at Marino in 1897, in a deep hole at lowest tide, and I believe no other was found at this locality until March 7, 1917, just twenty years later, when I found the two of which measurements are given above, both in the same hole, adhering to the upper side of a rock at lowest spring tide. All three were so densely covered with growth that they were most difficult to detect. I have twice found specimens washed ashore at Aldinga Bay, and Adams and Angas' type came from Rapid Bay, a little further down the gulf. Dr. Verco dredged a few specimens in the same gulf, so we may conclude that it is a fairly deep-water species.

Comparisons with other specimens.—I have one that I found washed up at Aldinga Bay, measuring 35 × 28 mm. dry,

in which all the valves except 2 and 8 are rosy-pink; valves 2 and 8 are greyish, and only tinged with pink; the girdle is rosy-pink, except where it is opposite valves 2 and 8, where it is blotched grey and white. The characteristic spicules, before described, are present in all my South Australian specimens. The sculpture in the smaller one is subpustulose in some of the ridges, especially the anterior margin of the lateral areas; the posterior margin is more strongly toothed than is the case with the larger specimens. Dr. Torr has several of the smaller size that show the same pustulose character in the sculpture. A specimen 30 mm. in length, dredged in St. Vincent Gulf, exhibits the same "spear-headed" hairs, and a small one, 23 mm. long, preserved in spirit, collected at Aldinga Bay, has the girdle well clothed with hairs terminating in similar "spear-head" spicules.

Remarks.—All specimens examined, collected by Dr. Torr, Dr. Verco, and myself, show the "spear-headed" spicules, and none of those examined from the other States exhibit this character.

Loricella torri, n. sp.

Differs from *Loricella angasi*, H. Adams and Angas, in that the white, "spear-headed" spicules on the girdle, and attached to the coarse hairs in that species, are absent in this.

The coarse hairs on the girdle are branching, and are, where perfect, transparent at their apices, but the transparent portions are the same width as the hairs and evidently the growing points thereof, and are very different from the broad, "spear-head" processes of *Loricella angasi.* The Sydney shell shows more raised and stronger ribbing. The anterior valve has 8 or 9 distinct rays, or coarse ribs, in addition to the closely-packed wavy ribbing. In one specimen in my collection from Sydney Harbour, the closely-packed wavy ribbing is almost absent, and in this one the ray ribs on the anterior valve, and the anterior and posterior margins of the lateral areas, consist of rows of elevated pustules. I think it possible that this character is more or less common to all juvenile specimens from New South Wales, and that with age these prominent tubercles are either eroded or absorbed. All the specimens that have come under my notice are more olivaceous than the South Australian shell.

Habitat.—The type I collected in shallow water at low tide at the Quarantine Station, Sydney, New South Wales, in November, 1918. I am presenting same to the South Australian Museum. It appears fairly common at Port Jackson, and frequents much shallower water than is the case with the South Australian species. I actually found one on a large rock several feet above low-water mark. I have one

dredged by Mr. Gabriel in 5 fathoms, at Western Port, Victoria, measuring 33 × 22 mm., in which the ray ribbing of anterior valve is well defined, but the closely-packed intermediate ribbing is hardly discernible, except near the margin; one of the coarse hairs on this specmen is 9 mm. long. Dr. W. G. Torr kindly showed me his Victorian specimens, which are similar to mine.

Tasmanian form.—Both Mr. W. L. May (of Tasmania) and Dr. Torr have been good enough to lend me their Tasmanian shells for the purposes of this paper. Mr. May writes that it is rare at Port Arthur. These Port Arthur specimens show a considerable divergence from most of the New South Wales shells, and are approached most nearly by the dredged specimen, before referred to, from Western Port, Victoria. The largest shell from Port Arthur is in Mr. May's collection, and measures 41 × 31 mm., has practically no decussation on dorsal or pleural area, but the smaller shell shows it to some extent; the riblets on the anterior valve are not as strong and the tail valve is more elevated than the New South Wales type. But the small shell from Sydney, before referred to, diverges from the type quite as much in these respects. I therefore do not feel justified in separating the Tasmanian Port Arthur shell from the New South Wales and Victorian ones; they all show the coarse, branching hairs on the girdle, without the strange "spear-head" processes that are present in the South Australian species.

Remarks.—The sculpture in this species shows a good deal of variation. Speaking generally, the ribbing is coarser and more defined in the northern shells and less conspicuous in the Tasmanian. But these characteristics are hardly sufficiently persistent to justify the making of a subspecies. It is just possible that there may be two shells in New South Wales, in which case one might be justified in separating the Tasmanian form. If there are no intermediates the small shell I have referred to might well be a second New South Wales species.

In conclusion.—In none of these specimens from New South Wales, Victoria, and Tasmania are the flattened finger-like processes margining the girdle developed beyond the incipient stage, and it is quite possible that this character may be peculiar to the adult shells of the South Australian species, but without the examination of a much larger amount of material from the other States I hesitate to quote this character as one of the distinguishing ones of the South Australian shell.

The measurements given in this paper show that the adult South Australian shell is much larger, often double the size, of its congener.

I am suggesting the name of *torri* for this species, after my friend Dr. W. G. Torr, to whom I am indebted for a good deal of material I hope to deal with in a future paper.

Addendum.

Since writing the foregoing Dr. J. C. Verco has sent me his stereoscopic microscope, and with the aid of this splendid instrument the following additional observations have been made:—

The so-called scales, with which the girdle is clothed, are of a distinct and peculiar character. The statement by Carpenter, published by Dr. Pilsbry (Man. Con., pt. 56, p. 239), that they "resemble grains of wheat set on end," is a very good one; they are bilobed, and shaped like the blunt or broad end of a grain of wheat, patches of them being level, almost like a cobble pavement; other patches are irregular, many standing up for more than half the length of the "wheat-grain" above the normal level. These bilobed, grain-like scales are, most of them, transparent and glassy; others, again, are opaque and white, but still with a glass-like appearance.

Between these "wheat-grains" the strange "spear-heads" push through and look like a cylindrical pointed spear-head made of porcelain, and are, I estimate, eight times the length of the scales.

Later, as the "spear-head" is pushed forward, a pale-brown, horny-looking tube, or stalk, is produced, which is heretofore described as a coarse hair, for want of better term, which, as it lengthens, buds. First the porcelain "spear-head" is produced, behind which the horny tube-like stem widens by the addition of an extra flute, ultimately becoming a distinct branch. In one or two instances a single stalk has branched six times and been furnished with six "spear-heads." These side branches are of a considerable length. often several times the length of the spear-headed apex. I believe the branches do not again bifurcate, although they appear to do so, due to the fact that three or four of these stalks come through the same aperture in the girdle, usually side by side rather than in a circle, as do the spicules in Acanthochitons.

The tubes, or coarse hairs, are pale horn-colour, highly polished, as if varnished, transversely striated; in some cases the striae are near together, but more usually forming somewhat distant rings for the whole length of the tube. In a few instances these striae are absent; in others the sulcae are broader and placed at greater distances, suggestive of segments or the knodes of a plant.

The spear-heads vary a good deal, both in size and shape. Some are long and lanceolate, sharply pointed; others are globose and blunt; many are oblique, slightly scimitar-shaped; all are equally white and glossy.

As before stated, the longer hairs, or tubes, take their rise in clusters fairly equidistant midway across the girdle, and are placed opposite the strange finger-like processes, those nearest the shell measuring up to 4 mm. in length, but becoming shorter and shorter as the margin of the girdle is approached until along the centres of the finger-like processes they are nearly all unstalked, and form a closely-packed row of porcelainous spear-heads, some still partly buried in the girdle. Along the front of the finger-like processes the spear-heads are small and scattered, not adhering to the mid-line, as is the case further back.

To the question, What is the function of the strange coarse hairs, or tubes, and their peculiar apices, and what purpose do they serve? I can find no definite answer. I do not think their purpose is either that of decoration or protection, for in life the shell and girdle are covered with growth. Also, it is most strange that the allied form occurring in the other States should not have similar spear-headed terminals to the hairs; possibly they do have them at an early stage, and dispense with them in the adult form, though in the specimens examined there is nothing to suggest this.

One is struck with the points of similarity between the genus *Loricella* and the North American genus *Placiphorella*, belonging to the family Mopaliidae. Mr. S. Stillman Berry, in his valuable paper on "Chitons taken by the United States Fisheries steamer 'Albatross'" (U.S. Nat. Mus. Proc., vol. 54), figures several of this genus which exhibit the following similarities: The girdle is much wider in front than behind, the foot is short and broad, and for the size of the shell small; the girdle is adorned with remarkable hairs, although these are structurally very different, but in pl. 9, fig. 6, he shows the presence of some minute spicules that are somewhat similar, though much smaller, to the "spear-heads" on *Loricella angasi*.

I have presented the type of *Loricella torri* to the South Australian Museum.

DESCRIPTION OF PLATE X.

Fig. 1. Shell of *Loricella angasi*, Ad. and Ang., ×½, showing in girdle, slit, fringed margin, and spicules, p. 60.

" 1*a*. Girdle of same, ×6, showing finger-like processes and spear-headed spicules.

" 1*b*. Girdle and part shell of *Loricella torri*, n. sp., ×6, p. 62.

" 1*c*. *Loricella angasi*, Ad. and Ang., ×2, underside showing animal.

" 1*d*. Spear-headed spicules and girdle margin of same, ×20.

Notes on Australian Polyplacophora, including Descriptions of Two New Genera, a New Variety, and the Description and Proposed Recognition of Mr. Bednall's Stenochiton pilsbryanus.

By Edwin Ashby F.L.S., M.B.O.U.

[Read July 11, 1919.]

Plate XI.

ISCHNOCHITONIDAE.

Genus Stenochiton.

Zostericola, n. subgen.

Differs from *Stenochiton (sensu stricto)* in that the shell is short and broad instead of being elongated and narrow. It possesses the highly polished and unsculptured surface and minute girdle scales so distinctive of the true *Stenochiton*. It also lives on the same order of plants *(Fluviales)* or sea grasses.

The writer foreshadowed the establishment of this genus in the paper on *Stenochitons* (Trans. Roy. Soc. S. Austr., vol. xlii., 1918), and included the subgeneric name of *Zostericola* in the distribution list published in the same number of the Transactions.

The name *Zostericola* is derived from the name of the genus of plants upon which it is said to have been found, and upon which it no doubt lives.

Type *Stenochiton pilsbryanus*, Bednall.

Zostericola pilsbryanus, Bednall.

Introduction.—In my monograph on the genus *Stenochiton*, mentioned above, I referred to the impossibility of reconciling any of the known species with Mr. Bednall's descriptions and drawings of *Stenochiton pilsbryanus* (Proc. Mal Soc., vol. ii., pt. 4, 1897). I trusted that the type would have reached Mr. Iredale in London safely, as only by reference to the type could the matter be cleared up. Mr. Iredale writes me (February 16, 1919), "I think you are right in naming the shell that has been called *pilsbryanus*. I queried it, as it did not agree with Bednall's figures at all. However, no *Stenochiton* seemed like that figure. The type seems missing, as the specimens I have marked 'type' do not agree with the figure, nor have I seen the dissections." Thus no help towards the elucidation of the problem is likely to come

from the late Mr. Bednall's collection, the material now being in the hands of Mr. Iredale, and reported upon by him as above.

When in Philadelphia last year Dr. Henry A. Pilsbry showed me some of the material that Mr. Bednall had sent him (at the time the description of *S. pilsbryanus* was written) as being the new shell. I easily identified in the material shown to me the three species *S. juloides*, Ad. and Ang.; *S. cymodocealis*, Ashby; and *S. posidonialis*, Ashby; all very small and juvenile.

It is therefore fairly evident that Mr. Bednall's drawings and descriptions were made from more than one specimen covering more than one species. I think it not unlikely that there was even a fourth species represented, as I did not see all the material. I therefore propose to refer the species I am describing hereunder to Mr. Bednall's species for the following reasons:—

(1) I am anxious to retain the names of my friend Dr. Pilsbry and my late friend Mr. Bednall as associated with the interesting genus of *Stenochiton*.

(2) It is desirable to keep our list of species free from those that are impossible of identification.

(3) The form I am describing corresponds most closely with the figure of the shell in Mr. Bednall's paper.

(4) Mr. Bednall's shell was practically from the same locality, "Troubridge Shoal, St. Vincent Gulf, on *Zostera*." Tapley Shoal is about 6 miles from Troubridge.

General appearance.—Broad and short, glossy, rounded, without sculpture; the anterior valve unusually broad, the last five valves tapering very slightly towards the posterior. The general contour of the shell closely resembles that of *Terenochiton matthewsianus*, Bednall; at a distance of a couple of feet it might easily be mistaken for that species.

Colour and markings.—In the dried specimen with the animal inside the anterior and posterior valves are antique brown (Ridgway's colour standard), shading in the centre valves to semi-transparent creamy-white, sparsely mottled with pale olive-green. A number of reticulate whitish markings commence at the posterior margin of the dorsal area, and spread fan-like anteriorwise. When disarticulated, and the animal cleaned away, the shell is very transparent. The brown anterior and posterior portions become pale-creamy and olivaceous, and the central valves transparent white and pale olive. Two wavy (broadly V-shaped) bands traverse both

the pleural and lateral areas, also other olivaceous markings are present.

Anterior valve.—Unsculptured; under a high power the valve is seen to be covered with whitish spots, suggesting regular decussation, but the brownish-olive mottling so generally covers the valve that in many parts the white spots are indistinguishable. The shell is convex, evenly rounded and arched, about twice as broad as long, teeth well defined, with rounded, slightly wavy edges, eaves well developed, teeth propped or fluted, slits 16, inside whitish and glassy.

Posterior valve.—Unusually broad for this valve, being only slightly less broad than the median valves, mucro slightly anterior, posterior slope evenly rounded but steep, convex. The portion of shell anterior to mucro is distinguishable from the posterior part, being smooth and slightly paler in colour; growth lines are visible on the posterior portion, also a slight ridge divides the portions, starting at the mucro and running diagonally to the suture. Behind the mucro is another half-moon-shaped shallow ridge, making a sort of false mucro. Inside the shell is white and transparent, multifissate. I counted 9 clearly-defined slits with square, broad-ended apices in the small terminal broken portion, but did not disarticulate the other and larger part of this valve. The teeth are round-edged, and are fluted or propped on the inside as in the anterior valves, eaves distinct.

Median valves.—Uniformly smooth, glossy, and unsculptured; the anterior margin of the lateral area is slightly raised, in some of the valves, especially in valve 2. The dorsal area barely distinguishable, but is slightly raised and flatly beaked. Under a low power 4 lateral, wavy, longitudinal, olivaceous bands are easily seen; one valve has six of these bands on either side. When disarticulated and cleaned and seen under a high power some additional markings are revealed. The dorsal and pleural areas are very distinct from the lateral, being covered with longitudinal wavy lines of a pale green tinge; these to a certain extent merge into one another, giving the reticulate appearance before referred to. This system of marking also covers the broad and flat beak; the broad interspaces are white. The lateral area is evenly covered with pale greenish spots, which suggest small pustules, but I am unable to discover any rising in the shell. In some lights, especially daylight, the white interspaces look like white spots and the olivaceous markings like interspaces. The sutural laminae are large, produced to about half the width (longitudinal) of the shell, and separated by a wide sinus; teeth fairly sharp, not rounded as in the anterior and posterior valves, and I can

find no sign of propping; 2 well-defined slits; inside transparent and glossy. The eaves under a high power are numerously notched, these being too shallow to term slits. The median valves vary in length, but are fully three times as wide as long, *i.e.*, the longitudinal measurement is one-third that of the lateral one.

Girdle.—Very narrow, and thickly clothed with minute, irregular, flattened scales, which do not appear to imbricate. Darkish blotches are noticeable opposite each suture.

Measurements.—The shell in the dried specimen is 5½ mm. by 3 mm.; it is more than likely that a live specimen would measure 6 by 3½ mm.

Locality.—I am indebted to Dr. Torr for the specimen described above, and he has loaned it to me for the purposes of this paper. He had it from the collection of the late Professor Ralph Tate. It is labelled in his handwriting, "Tapley Shoal, living on *Zostera.*" This shoal is about 6 miles from Troubridge lighthouse, south of Yorke Peninsula, in South Australia.

Type.—The type will remain in Dr. Torr's collection, but he has informed me that it will ultimately be placed in the South Australian Museum.

A second specimen, measuring just under 4 mm. by about 2 mm., and therefore half as wide as long, was collected by myself at Marino, probably on *Posidonia*, on February 19, 1910. These are the only two specimens that up to the present have come under my notice. This being a well-preserved, although a diminutive one, its colouration is more likely to be normal than is the case with the type. I therefore append a description.

General colour.—Serpentine green (Ridgway's Colour Standards, pl. xvi.). The valves 2 to 4 have the dorsal area outlined with a broad V-shaped white mark. The posterior and apical portions of anterior valve are white. The sides are broadly and irregularly banded with white. The girdle has a broad darkish blotch at the sutures; the two opposite the sutures of the anterior valve are black; there are seven irregularly-spaced blotches in front of same valve.

Shell.—The shell is more beaked than is the case with the type, and there is a slight elevation of the dorsal area near the beak in the first four valves. Starting at the posterior margin of the beak are a few shallow, circular elevations, which die away towards the middle of the anterior portion of the lateral area. These elevations are only seen in some lights with a high-power lens. The whole shell is highly polished and transparent.

Plaxiphora matthewsi, Iredale.

(Proc. Mal. Soc. Lon., vol. ix., June, 1910, pp. 96-100.)

Frembleya matthewsi, Iredale (Dis. List. Austr. Polyplacophora, Ashby: Proc. Roy. Soc. S. Austr., vol. xlii., 1918, p. 85).

I notice this season that each of the three small specimens of the above shell that have fallen to my lot during this summer's collecting have a remarkable feature present on the girdles, previously unnoticed. On reference to my cabinet I find that this feature is present in all my specimens, which include the following localities: Marino, Cape Jervis, Encounter Bay, and Port Lincoln.

New feature.—The feature referred to is the presence of a large number of slender processes, which for want of a better term we will call spicules, surmounted with strange porcelainous heads. These are not cylindrical, as in *Loricella angasi*, and which were described in my earlier paper of this year, but are flat on one side and rounded on the other, and are curved like the blade of an oar or scull, but sharply pointed. The surface is highly polished and white, in some lights, showing a few transverse lines; the stalk, bristle, or spicule, as it is previously called, is in fully-developed specimens long and slender and much curved (sickle shaped) when dry. The size of these heads varies considerably; some are fully half the length of the stalk that supports them, others again are supported on long stalks and have shorter heads: all the heads are broad-based, curved, and pointed at apex. They take their rise chiefly near the outer edge of the girdle, but many are sessile, only the porcelainous blade can be seen pushing out of the girdle amongst the short ordinary spicules which form the girdle fringe.

Girdle spicules.—The species under discussion has three forms of spicules—if these oar-headed processes can be termed spicules at all. There are the long, coarse, dark brown spicules or bristles that take their rise in bunches at each suture; these are taper-pointed, like a needle. Then there are a great many short, transparent, rather blunt-pointed spicules that form the fringe of the girdle. Lastly, there are these organs that I have termed oar-headed spicules, the stalks of which are semi-transparent and pale brown.

Comparisons.—While all the specimens I have collected exhibit oar-headed spicules, I have two, given me by Mr. W. L. May, of Tasmania, from Port Arthur in that State, that show no such spicules, which of course may be due to careless handling, but although Messrs. May and Iredale refer this Port Arthur form to the species under review, there are certainly differences both in the girdle and in the sculpture,

so that further investigation may not unlikely prove them distinct. Mr. May is endeavouring to obtain some fresh material. Then, again, I have a single shell that I collected at Port Lincoln, which is strongly carinated, but otherwise both in girdle and sculpture approaches the Tasmanian shells, and in this specimen also there is no evidence of the strange oar-headed spicules.

Family MOPALIIDAE, Pilsbry.

Kopionella, n. gen.

Differs from *Plaxiphora*, Gray—

(1) In having peculiar oar-headed girdle bristles or spicules.

(2) In having an elevated, recurved tail valve with terminal mucro.

(3) The minor differences detailed hereunder.

Differs from *Frembleyana*, H. Ad.

(1) In having peculiar oar-headed bristles or spicules.

(2) In the slits in the median valves being centrally situated and sinus, especially in tail valve, being much narrower.

(3) The minor characters detailed below.

Type.—Plaxiphora matthewsi, Iredale. The specimen described herein is being presented to the South Australian Museum.

Description and comparisons of further differences.—For purposes of this comparison *Plaxiphora albida* is used as typical of the genus *Plaxiphora*. In *P. matthewsi*, Ire., the upper side of the tail valve is very distinct from *P. albida*, Blain., in that the anterior and posterior margins of the tegmentum are so folded over as to form strongly-raised ribs; the mucro is terminal, much raised, and slightly recurved, as in *Loricella*. Inside the sinus is comparatively narrow and deep, whereas in *Plaxiphora* the sinus is wide. In the median valves of *P. matthewsi* the tegmentum of the upper-side is folded over to the inside, and forms there a strongly-raised rib, extending from side to side; in the anterior valve this folding forms a still deeper and sharper ridge. While there is the infolding in the *Plaxiphora*, this characteristic ridge is not formed. The teeth of the anterior valve are much more cleanly cut and less clumsy and thick than is the case in the *Plaxiphora*. The slits in the median valves show a striking feature in that that portion abutting on the slit is carried upwards under the eaves in two pillars.

Affinities.—It is a little difficult to know where the proposed new genus should be placed. Dr. Pilsbry points out (Man. Con., vol. xiv., p. 312) that the genera *Placiphorella* and *Mopalia* are separted from the *Plaxiphora* in that the tail valve of the latter is unslit, with the additional character in the former of "peculiar girdle bristles"; now the species under review has the tail valve unslit, as in *Plaxiphora*, but has, on the other hand, a striking character in its "peculiar girdle bristles."

I pointed out in my paper on *Loricella* some points of similarity between that genus and *Placiphorella*. Since writing my description and preparing figures of the new features noted in *P. matthewsi*, I have noticed Messrs. Iredale and May's remarks on this species in their valuable paper (Proc. Mal. Soc., vol. xii., pts. ii. and iii., Nov., 1916, p. 101), where they say, referring to *P. matthewsi*, "Receipt of well-preserved specimens from Tasmania shows that the species has no close relationship with *Frembleya*, the animal being obviously different. This is now being investigated, but in the meanwhile a nearer ally from a superficial examination might be *Loricella*."

The outward appearance of the tail valve certainly suggests *Loricella*, and the strange girdle bristles do still more so, but the unslit tail valve and the non-emarginate girdle show a closer affinity with the Mopaliidae, Pils. For the present I think we must leave the suggested new genus under Plisbry's family Mopaliidae, but future research may necessitate some revision of this family and that of the Liolophurinae.

Rhyssoplax torrianus, H. and H., var. klemi, nov.

Amongst the specimens of the above chiton collected by Dr. Torr and Mr. Klem at Corny Point, Yorke Peninsula, is a rather striking variant from the normal form. The usual deep, longitudinal sulci, edged with black, which traverse the pleural areas, are reduced in this specimen on some valves to three, on others four on each side, and the similar black dashes on the dorsal area vary from one to two on each side. Again, the sulci are hardly developed at all, and the black lines are most of them mere dashes on the posterior portion only, of the pleural areas. The general effect is rather striking, the shell looking decidedly bare of markings and sculpture. The specimen is in Dr. Torr's collection.

This variety appears sufficiently distinctive to deserve a name, and therefore I suggest that it be known as var. *klemi*, after the gentleman who was co-worker with Dr. Torr at the time it was collected.

ANISORADSIA MAWLEI, I. and M., subspecies SAUNDERSI, Ashby. (Trans. Roy. Soc. S. Austr., vol. xlii., 1918.)

In my "Notes on South Australian *Polyplacophora*" I gave a brief description of a new chiton, giving it the name of *saundersi*, and placing it, with some doubt, as a subspecies of *Anisoradsia mawlei*, I and M. Since my return from America my friend Mr. W. L. May has supplied me with some splendid specimens of that species, and I can now authoritatively say that I was wrong in placing it in that genus. I am sending the type to Mr. Iredale for his comments, as in 1917 I sent him a second specimen collected at the same time and place.

DESCRIPTION OF PLATE XI.

Fig. 1. Portion of shell and girdle of *Kopionella*, n. gen., *matthewsi*, Iredale, ×25, showing oar-headed spicules in girdle, p. 71.

,, 1*a*. Girdle of same, ×100, showing oar-headed spicules, sutural spicules, and fringe spicules.

,, 2. Shell of *Zostericola*, n. gen., *pilsbryanus*, Bednall, ×9, p. 66.

,, 2*a*. Anterior valve of same.

,, 2*b*. Median valve of same.

,, 2*c*. Inside of median valve of same.

,, 3. Shell of *Rhyssopplax torrianus*, H. and H., var. *klemi*, n. var., ×4½, p. 72.

NOTE.—The enlargements are only approximate.

A New Species of *Aganippe* from Kangaroo Island

By R. H. Pulleine, M.B.

[Read July 11, 1919.]

Plate XII.

Aganippe rainbowi, n. sp.

♀. Described from living specimen. Cephalo-thorax, 5 mm. long, 4·5 mm. broad.

Cephalo-thorax:—Obovate, nearly as broad as long, black or very dark brown, shining, entirely devoid of hairs except two or three stiff ones between the eyes.

Pars cephalica:—Elevated, arched, distinct segmental groove.

Ocular area:—Twice as broad as long, raised, arched, and provided with bristles.

Clypeus:—Narrow, sinuate, sloping forward, weakly indented at middle.

Pars thoracica:—Broad, fully curved at sides, sloping backwards, well-marked radial grooves.

Fovea:—Deep, short, procurved.

Marginal band:—Hardly sinuate, bare of hairs.

Eyes:—Front row very slightly recurved, the laterals equal in size or slightly larger than medians, are elevated on black bases, looking forwards and outwards. The medians, separated by rather more than their diameter from the laterals, are not elevated, and are separated from each other by one-half the diameter of a median eye. Posterior row procurved. The laterals are the larger, nearly equal in size to the antero laterals. They also are raised on elevated bases, looking backwards and outwards. The medians are small and not elevated, their inner border is convex, and their flat outer border is in contact with the base of the corresponding postero lateral. The distance between the postero medians is exactly that of the extreme outward limit of the antero medians.

Legs:—Similar in colour to thorax; relative lengths, 4, 1, 2, 3; the two anterior pairs armed with long black spines, 5 metatarsi, and tarsi of 1 and 2 scopulate. Tarsal claws well developed. Two posterior pairs less robust, clothed with long stiff hairs and an occasional spine.

Palpi:—Concolourous with legs, robust, clothed with stiff hairs and bristles, tarsal joint scopulate.

Falces:—Black, shining, well domed, forward. Teeth of rastellum minute, shining, brown. Fang long, curved.

Maxillae:—Warm, yellowish-brown, furnished over greater part with regularly-set short dark spines, and sparsi thin black hairs. Inner-margin clothed with dense long silky hairs or reddish-brown colour.

Labium:—About as broad as long, beset with about 20 short stout black spines in its central area.

Sternum:—Pale yellowish-brown, slightly arched, sparsely clothed with black hairs; broadly pyriform with well-marked margin. Posterior sigilla, circular away from margin.

Abdomen:—Dark brown, short, as broad as long, densely clothed with dark hairs, raised on papillary bases, giving the surface a markedly shagreened appearance. No dorsal design apparent. There are two well-marked circular lateral pits near the anterior margin of the dorsum, which slightly overhangs the cephalo-thorax. Under-surface lighter towards centre, clothed as on upper-surface with hairs arranged more or less in transverse lines. Posterior lung sacs large, transversely ovate, sparsely clothed with fine curved black hairs.

Spinnerets:—Concolourous, superior pair slightly longer than inferior pair and about half as broad at the base.

♂. Described from dried specimen. Cephalo-thorax, 4 mm. broad, 4 mm. long; abdomen, 4 mm. long.

Cephalo-thorax:—More circular than in the female, flatter, less elevated in front.

Fovea:—Short, procurved, radial markings indistinct.

Eye:—Formula identical with that of female, but eye area not bristled. Whole surface of thorax finely granular instead of polished, well-marked sinuate marginal border.

Legs:—More slender, lengths 4, 1, 2, 3; armature of strong spines, clothing less marked, no tibial mypophysis.

Palpi:—Brownish-black, no tibial apophysis, tibial joint large and inflated, unarmed, and sparsely clothed. Bulb concolourous, highly polished, stigma narrow, twisted, terminating in filiform style.

This is much the smallest species of *Aganippe* yet discovered. Several females and one male were collected in May, 1919, at American River, Kangaroo Island, South Australia. American River, so called, is really a deep bay nearly dividing Kangaroo Island in two.

The species was found close to the main settlement in rubbly clay banks, just above high-water mark, and at high tides the nests must be very close to, if not in actual contact, with the salt water. The nests are abundant and in places

crowded together, so that a few cubic inches of clay will contain several nests.

The male, which unfortunately became dried, was in a nest like the females.

The largest nest taken is 6 cm. in total depth, straight, and densely lined. The aperture, which has a lumen of 8 mm., is closed by a stout, circular door with an attachment of one-fourth its circumference to the tube. The door is flat on the under-surface and roughly heaped up on the outer-surface. The total width of door 15 mm. wide, 11 mm. from hinge to front. In one nest twenty young were found with the female, but in none were egg-cases found. Another nest contained the complete cocoon of a leaf-cutting hymenopter.

Apart from its small size, the characteristics of this species are the dense spiny armature of the anterior two pairs of ambulatory legs and the palpi.

Types 1 (male) and 2 (female) in Australian Museum, Sydney; 2 (female), co-type in South Australian Museum, Adelaide.

DESCRIPTION OF PLATE XII.

Aganippe rainbowi, n. sp.

Fig. 1. Female, dorsal view.
,, 2. Female, ventral view.
,, 3. Male, palpus, lateral view.
,, 4. Nest, closed.
,, 5. Nest, open.

Notes on the Occurrence of Aboriginal Remains below Marine Deposits at the Reedbeds, Fulham, near Adelaide.

By S. A. White, C.M.B.O.U.

[Read July 11, 1919.]

In 1893 Mr. William White, of the Reedbeds, conceived the idea of forming a small lake as a sanctuary for water-fowl and other birds. For this purpose he leased a piece of ground from his younger brother (now deceased) situated close to what was once a large swamp, and only a few hundreds of yards from the sand-dunes near Henley Beach South. This part of the country has been in the possession of the family from the first, my grandfather, the late John White, having settled there prior to the proclamation of the Colony in 1836.

The excavation required in the formation of the artificial lake was carried out entirely by hand labour and hand tools, and the excavated materials were carted to one side and tipped, making a considerable mound around the lake. The cost of labour alone amounted to over £1,500, in addition to the personal costs and years of hard work done by the owner.

The locality where the work was carried out was swampy, being in the channel of the flood waters which sometimes came that way from the River Torrens, and yielded a swamp vegetation, especially the "cutting grass" *(Cladium filum)* that was used in the olden days for thatching.

The following is a statement of the various beds passed through in making the excavation:—

	Ft.	In.
1. Alluvial soil	1	6
2. Blue clay, very slimy and difficult to remove. At the bottom of this clay there were pockets of seaweed, some of which were quite decayed while other parts were well preserved ...	1	6
3. Hard, rusty-coloured sand, sometimes cemented together with sea shells	3	0
4. Hard black clay on fairly level bed	0	10-16
5. A peculiar formation of "swamp-stone," occurring in denticulated or stalactitic concretions, in yellow sand	3	0
6. Pure white sand (not bottomed)	10	0

As soon as the white sand was reached several clay-lined basins were exposed. The clay was from half an inch in thickness at the rim to 2 inches, or more, towards the bottom of the depression. Close to one of these basins was a length of black

Sandy Soil
1 ft. 6 in.
Blue Clay.
1 ft. 6 in.
Estuarine Sand and Shells.
3 ft.
Black Clay, with Freshwater Shells.
Varies from 10 in. to 16 in
River Sand, with Calcareous Concretions
3 ft.
White Sand.
10 ft.
(not bottomed).
References.
X, Xa, Xb, Clay Basins, seen in section.
1a, 1b, 1c, 1d, position of four of the cores, or Pounding Stones.
2. Circular Hammer stone.
3. Position of Oval Fabricator.
4. Beach Stone, unworked.
5. Carbonized Stick.
x
4
1a 1b 5
xa
1c 1d
2
xb
3

carbonized wood, that was inclined towards the basin. This was probably the remains of a spear handle or pointed stick of hardwood that had been thrust into the sand alongside what, I believe, to have been a dipping-place for water by the aborigines.

Close to these dipping-places, and but slightly embedded in the surface of the white sand, were five cores of quartzite, that gave evidence of having been flaked by human hands. Four of these lay in pairs, quite close together, just as if the owners had laid them down after using them, probably for grinding their food.

The excavation was carried down another 10 feet, through the white sand, but as this bed was of the nature of a quicksand, great difficulties were met with in its removal, for when left for a few hours the sand would cave in and reach its former level, so that after a depth of 10 feet was reached in this bed the work was stopped without reaching its bottom.

It may be said that the benevolent intentions of the owner of the ground were to some extent realized. The surroundings were planted with a variety of native shrubs and trees which afforded both shelter and food for the birds, and these soon took advantage of this sanctuary, where they nested and became exceedingly tame, as did also the land and water snakes, which made friends with their human protector, whom they came to recognize. In the course of time the proximity of population and frequent raids of trespassers nullified the main objects for which the lake had been established.

The clay basins, which I suppose to be dipping-places of the aboriginals, were all on the same level, two were fairly close together, while the third was further apart. I closely examined the hard clay to discover, if possible, finger-prints, but without success. Anyone seeing these basins could form no other idea but that they were made by man.

I have never seen anything resembling this kind of construction by the aboriginals of Australia, but strange to say, at a place called Kisimayu on the East Coast of Africa near the Somali Land border and right on the coast, I found some years ago natives making mud-lined basins in the sand to hold water. These were very like the ones described in this paper, only for shape, the African basin being much longer than they were wide, while two of the Australian ones were almost circular in shape, the third being a little depressed on the sides. The clay which composed these basins was dark in colour and very hard, the sand had drifted into all three, and it was only when a workman cut through one that their presence was made known. On discovering a second one the sand was cleared away, but the basin evidently had cracks in it,

and would not stand its own weight, and fell to pieces. The carbonized wood was very distinct, and the outline of the spear or pointed piece of wood could be followed quite easily, but as soon as an attempt was made to remove it from its bed in the sand it fell to pieces.

The large round hammer-stone and the smaller one with chipped sides and ends were found in the white sand and were elevated some 6 or 8 inches above the level of the clay basins and the chipped cores, or grinding-stones, but in a line with them and on the extreme right of the sketch-plan. I think it is quite possible that this raised position upon which the two stones worked by the natives rested was due to the sand being forced up from below, for, as I have already said, when the water level in this sand bed was reached, in spite of 2 or 3 feet of sand having been taken out, in a few hours it had risen to its original level. There were no shells seen in this white sandy bottom, although sea-shells were met with in numbers higher up.

In the early days, when the blacks were numerous on the Adelaide Plains, they pulled up the roots of flags and pounded them between stones prior to cooking. One strangely-shaped stone which may have been used by the aborigines, added to the objects already described, were all that remained to indicate the occupation of the ground by a tribe of blackfellows that must have long since disappeared.

I have to thank Prof. Howchin, F.G.S., for his advice and interest in this subject. The Professor was good enough to accompany me and view the site of the excavation, and I am pleased that he will add his valuable scientific views upon the subject.

The section shown in the accompanying diagram is based on particulars entered in my note-book at the time of the excavation, and is drawn to scale.

Supplementary Notes on the Occurrence of Aboriginal Remains discovered by Captain S. A. White at Fulham (described in the preceding Paper), with Remarks on the Geological Section.

By Prof. Walter Howchin.

[Read July 11, 1919.]

Remarks on the Beds passed through in the Sinking.

The particulars supplied by Capt. S. A. White relate to a vertical section of over 20 feet. Samples of several of the beds passed through have been kindly placed at my disposal for examination by the author of the paper, and the following remarks have reference to their geological features. The numbers prefixed to the paragraphs correspond to the respective beds in Capt. White's descriptions.

Bed No. 2.—The blue tenaceous clay, underlying the surface soil, probably represents the settlement of fine clay in the flood waters of the River Torrens when the ground was slightly above sea level, or the stage when the salt and fresh waters commingled; the pockets of sea-weed in the lowest portions of this clay give evidence of this.

Bed No. 3.—This bed, 3 feet in thickness, represents the characteristic marine sands and estuarine fauna which form the banks of the Patawalonga, in the nature of a raised sea bed. In the sample submitted to me I observed the following mollusca:—*Ampullarina quoyana, Trochoconchlea constricta, Risella melanostoma*, and *Nassa pauperata*, all of which are common estuarine forms in the adjacent waters. The matrix is a slightly-cemented, somewhat coarse sand, mottled with iron stains. This bed gives evidence that the estuary of the Patawalonga Creek formerly reached this far north, about half a mile beyond its present limits. Its upper surface has been rucked by two channels of erosion subsequently to its deposition.

Bed No. 4.—Beneath the raised sea bed, as described above, is an indurated black clay with its upper surface showing a plane of erosion, varying in thickness from 10 inches to 16 inches. This is evidently a freshwater deposit, laid down in marshy ground that carried an extensive vegetation of some kind. No plant remains can be detected in the main body of the clay, but near the top of the deposit a somewhat lighter-coloured clay occurs in which are seen the shells of the fresh-water snail, *Limnaea*. When a portion of the black clay was placed in water it passed down to an impalpable black mud, and after washing, left a residue of exceedingly fine white sand, mixed with black granules of a carbonaceous kind.

Bed No. 5.—Only the stalactitic concretions were available for examination from this geological horizon. The particular example shown me by Capt. White is 8 inches in length and numerously branched, reticulated and denticulated. Its composition is that of a fine sand calcareously cemented. Nodules and variously-shaped concretions of this kind commonly occur in deposits of fine alluvial sand, and can be found under such conditions in the banks of the River Torrens near Adelaide. They were also present in the alluvial bed, exposed under marine deposits, in the excavation made for Fletcher's Graving Dock.(1) The bed containing these nodules at the reedbeds is undoubtedly of freshwater origin, probably laid down as river wash.

Bed No. 6.—The white sand which formed the lowest bed in the section, and was not bottomed, has all the appearance of a wind-blown sand. It contains no organic remains, is of uniform grain, and is practically free from any cementing agent. In the excavation it had the character of a running sand which flowed in as fast as it was shovelled out and stopped all further sinking. It was probably formed as an ancient sand dune, the base of which is below the present sea level.

The Stone Implements.

The stones showing aboriginal workmanship were of three kinds: pounding-stones or cores, a hammer-stone, and a fabricator.

1. *Pounding-stones.*—There are five belonging to this class, and these exhibit certain features in common, having a flat base and are roughly chipped in a way that might make them convenient for handling. The general form is very like the cores that are left after flakes have been struck off for making knives or scrapers, but the chippings have been too irregular and ill-shaped for such a purpose. Capt. White's suggestion that they may have been used for crushing, or pounding, is therefore probable, although the flat faces give no sign of wear.

Lithologically these pounding-stones belong to two kinds of siliceous rocks. Four of these have been obtained from boulders of quartzite washed down from the hills in the vicinity of Adelaide. The fifth is a siliceous rock, of coarser grain, and the cement consists of colloid silica. The four first-mentioned are of Cambrian age and are of metamorphic origin, while the last-named is of Recent age and formed part of the consolidated sands of the older drainage system of South

(1) Howchin: "Remarks on a Geological Section at the new Graving Dock, Glanville, with special reference to a supposed Old Land Surface now below Sea Level" (Trans. Roy. Soc. S. Austr., vol. x. (1887), p. 31).

Australia. One of the quartzite specimens, the smallest of the four, shows conchoidal fracture in the flat face and has been carefully chipped into an almost circular outline at the base.

2. *Hammer-stone.*—This is a very siliceous quartzite, $3\frac{1}{4}$ inches in diameter, circular in outline, thick, and flattened on two sides. Weathering has removed what was probably small granules of kaolin that were interspersed with the quartz grains, leaving the stone somewhat open. It is also bleached to a white colour, probably the result of deoxidation through contact with vegetable matter in the beds. It gives evidence of extensive use on the edge which has been worn back to a flat face about an inch in width.

3. *Fabricator.*—This tool is an oval-shaped, flattish pebble, $2\frac{3}{4}$ inches in the greater diameter, the parent rock being the very fine-grained quartzites that make a prominent feature at Sellick Hill. This class of stone, on account of its fine grain and conchoidal fracture, was a favourite stone with the aborigines of the Adelaide tribe for making their implements. It occurs on the beach and in the paddocks along the coast between Sellick Hill and Marino. The example found in the Reedbeds section is perfectly typical in its evidence of wear. The edge is much worn, especially a little aside from the obtuse ends of the stone, arising from the manner of its use in striking off flakes, and there is also considerable wear on the two flat faces at right angles to the former. After extensive use these fabricators assume a cruciform outline. No stone flakes, knives, or other worked stones were found where these implements occurred, but the presence of this fabricator proves that such definitely shaped stones were in use at the time to which the remains belong.

4. *Casual Stones.*—Two stones of an indefinite character were found at the same place. One a rough chip of weathered quartzite, circular in outline and having a diameter of $2\frac{1}{2}$ inches. The other, a flat, water-worn, elongated stone, about 6 inches in length and $1\frac{3}{4}$ inches in breadth, belonging to the purple-slates series of the Upper Cambrian. Stones of this kind are common as beach stones on the local shores; it gives no signs of having been used in any way, but it could only have occurred in the position in which it was found except by human agency.

The Age of the Aboriginal Remains.

The mean level of the site on which the excavation was made, according to official figures, is at or about high-water level. The situation is near the western margin of the flood waters of the River Torrens over the area known as the Reedbeds, and about half or three-quarters of a mile to the

northward of the highest position of the Patawalonga Creek. From Capt. White's section it is seen that at present there is three feet of blue-clay and alluvium at the site covering the estuarine deposits. It is probable that the silt laid down by the flood waters of the Torrens is responsible for damming back the tidal waters of the Patawalonga to the extent mentioned above.

The position in which the aboriginal remains were found, *viz.*, 10 feet from the surface, places them either at or a little below low-water mark, while immediately above them is a fluviatile bed, 3 feet or more in thickness, capped by a fresh-water lagoon deposit. Following these river and swamp conditions we find an incursion of the sea over the area which resulted in the laying down of 3 feet of estuarine sediments.

At the time of the human occupation of the site, neither the river nor the sea had covered the locality, which was occupied by sand drifts, and it was on these sand hills that the aboriginals were camped. As the ground was excavated by Mr. White, sen., in these blown sands to a depth of 10 feet below present low-water mark, there seems very clear evidence of a sinking of the land to the extent of several feet, at least, since the aboriginal camp was occupied.

Evidences of alternations of level on the coast are supplied at other places. The interbedding of marine and freshwater beds at Glanville *(loc. cit.)* may be compared with the section now described, both of which show that, within recent times, the land has stood higher than it does at present.

No evidence of aboriginal remains have been noted, hitherto, in South Australia other than in the most superficial deposits. The case before us appears to have a higher antiquity than any previously noted. The suggestive points are:—*(a)* The sand hills in which the aboriginals formed their camp are now below sea level; *(b)* in the interval separating that time from the present there have been several important changes in the physical condition of the neighbourhood, the sand hills gave place to a river course, the sediments of which have since developed stalactitic concretions; after which, the river stage passed into that of a swamp; then followed an incursion from the sea; and, in more recent times, the area has been covered with mud laid down by the stagnant waters of the Torrens. These successive changes require a considerable length of time for their accomplishment and an undoubted antiquity for the human remains. At the same time it must be noted that the materials used by the aborigines of that day, as well as the types of implements and the methods of manufacture, are identical with those adopted by the latest representatives of the race.

A Contribution to the Study of Habronemiasis: A Clinical, Pathological, and Experimental Investigation of a Granulomatous Condition of the Horse—Habronemic granuloma.

By Lionel B. Bull, D.V.Sc.,
S.A. Government Laboratory of Pathology and Bacteriology, Adelaide Hospital.

[Read August 15, 1919.]

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A.—Introduction.

In 1916 the present writer recorded the occurrence in Australia of a granuloma which, in his experience, was most frequently found affecting the external genitalia of the horse. The condition was found to be of rather infrequent occurrence. It was first observed in 1912, and from this time onwards an occasional specimen was obtained. It was not until the early part of 1914 that the granuloma was found to be due to a larval Nematode.

These preliminary observations were recorded, and up till that time no record of the occurrence of the condition in Australia had been made.

The condition was described under the name of habronemic granuloma, and the opinion was expressed that it was none other than the granulomatous affection found commonly in the horse and ass in various parts of the world, and known usually as "summer sores," or "granular dermatitis." An hypothesis was advanced that a biting fly was in some way responsible for the introduction of the larvae into or beneath the skin of the animal, and as a larval *Habronema* had been described as occurring in *Stomoxys calcitrans*, it was thought that this fly was incriminated.

The present communication recapitulates the original observations, and records further observations and experiments. After an investigation into the life-histories of the three species of *Habronema* found in the stomach of the horse, and after an experimental investigation of the cause and nature of the tumours, the original hypothesis has now to be considerably modified.

Since the disease was first recorded as occurring in Australia, Lewis and Seddon (1918) have recorded the occurrence of the condition in the region of the conjunctiva of horses in Victoria.

Place (1915) in a previous publication had attempted to prove that the occurrence of malignant neoplasms in the orbit of the horse was commonly associated with the presence of larval Nematodes in this situation, and although he incriminated a larval *Habronema*, there was no record of the worm having been isolated and identified.

A further macroscopic and microscopic study of the granuloma occurring in horses in the northern parts of Australia, and commonly called "swamp cancer," has been made, and the observations are outlined below.

The literature bearing on the subject of "summer sores" and other similar conditions is reviewed and discussed in the following paper.

Macroscopic and microscopic examinations of a granuloma found affecting horses in the Solomon Islands are also recorded below.

B.—Granulomata as found in Southern Australia.

Distribution.—Up to the present these granulomata have only been met with by the present writer in the northern parts of Victoria and in South Australia (the only parts of Australia in which the writer has worked).

On the whole they appear to be more common in South Australia than Victoria. There is no reason to believe that they do not occur elsewhere in Australia, but it is probable that they are to be found more commonly in the warmer parts.

Occurrence.—These tumours have only been met with during the summer and autumn months of the year. They occurred in stable-fed animals, and a large proportion of the cases have been stallions which have been kept in the stable for longer periods than ordinary working horses.

Site.—The tumours are found most frequently upon the glans penis at the urethral orifice, but also quite commonly on the sheath. When they occur elsewhere they are found most commonly on the limbs. Only two cases where the lesions have occurred in parts other than the penis and sheath have come directly under the writer's notice. In these cases the tumours were situated in the metacarpal region and in the region of the hock, respectively, and were accompanied by lesions in the usual site.

In February, 1917, through the courtesy of Mr. H. R. Seddon, Melbourne University Veterinary School, the writer had an opportunity of examining a specimen of similar character taken from the *membrana nictitans* and lower eyelid of a horse. Mr. Seddon was informed by the sender that lesions were fairly frequently observed in this situation.

Lewis and Seddon (1918) have recorded the occurrence of similar lesions in the conjunctiva of the horse.

There seems to be no doubt that, as the knowledge of the characteristics of these granulomata becomes more widespread, they will be found to occur quite frequently in situations other than the external genitalia.

Duration.—The tumours appear fairly suddenly, and grow rapidly for the first two or three weeks. From this time onward they gradually enlarge, and they usually show no tendency to disappear, although there is some evidence to show that occasionally the lesion may be quite transient. Most of the tumours met with have been removed surgically, so that there has been little opportunity of observing the

duration under natural conditions. In one case, however, the tumours persisted for several months, and, although decreasing in size, did not completely disappear even during the winter.

Clinical examination.—Typical tumours of several weeks' duration are recognized by their situation, their tough fibromatous nature, and by the appearance of small yellowish points lying beneath the mucous membrane or the unpigmented epithelium or, if ulceration is present, in the floor of the ulcer. They are found to be attached to and involving the skin. Lesions of only several days to two or three weeks' duration are more difficult of recognition, for they have not developed the characteristic yellowish points. Ulceration has rarely occurred at this stage. A history of a more or less sudden appearance, without any evidence of injury or bacterial infection, may help one in making a diagnosis.

Macroscopic examination.—The tumours may be single or multiple, and those of some weeks' duration are usually ulcerated on the surface.

When situated on the glans penis they vary in size from that of a pea to larger than that of a walnut. The largest specimen examined measures 5 cm. in length, 2·5 cm. across the broadest portion, and 2 cm. in depth. The tumours on the sheath attain a greater size, one specimen measuring 6·5 cm. across the larger diameter, 4·5 cm. across the smaller diameter, and 2 cm. in depth. Much smaller tumours, varying in size from that of a lentil to that of a pea, and showing a single yellowish caseous area in the centre, are sometimes seen, and are usually multiple.

On section of a typical tumour of several weeks' duration it is seen that the tissue is tough, firm, and fibrous, greyish to pinkish in colour, and contains scattered throughout the mass irregular, yellowish, caseous areas varying in size from points just visible to the naked eye to areas about 1 mm. in breadth by 4 or 5 mm. in length, or even larger. In tumours from the penis these caseous areas lie closer to the urethral than the external surface.

At times these caseous areas may contain some calcareous deposit. They may be situated closely together or scattered sparsely throughout the tumour and, in the older lesions, may be fairly easily enucleated. On enucleation it is seen that in each individual lesion they have much the same consistence and colour, but vary in form. Those from an older lesion are irregular in shape, yellow in colour, and hard, often presenting a branching appearance.

The points of caseous tissue seen on a cross section are found to be parts of a larger area. No transition between an

early, small, and an old, large caseous area is to be found, nor is there any evidence of a young bud or extension.

On section of an early lesion, one of two to four weeks' duration, it is seen that the tissue is less tough and pinker in colour. On careful examination small, pale-yellowish, caseous areas are seen scattered throughout. These are much smaller, paler, and softer than the areas seen in older lesions, and are enucleated with difficulty.

The rather denser nature of the tissues in the glans penis apparently prevents the tumours reaching the size they attain in the looser tissues of the sheath, and, likewise, the tissue reaction is greater in the tumours from the latter situation.

The appearances of the lesion removed from the metacarpal region of the case mentioned above vary somewhat from those found in lesions from the penis and sheath. Beneath the ulcerated surface there is dense, sclerosing, fibrous tissue extending 5 mm. in depth, which has probably resulted from treatment with antiseptics. Beneath this is looser fibrous tissue containing translucent, greyish areas, somewhat circular in shape, and containing sometimes a yellowish point.

The lesions observed by Lewis and Seddon were of the nature of a granuloma, involving the inner canthus of the eye and the membrane associated as a rule with irritation of the cornea and lacrymation. Yellowish necrotic areas were seen in the submucous, and sometimes the subcutaneous tissues. They were found on both surfaces of the membrana and in the skin of the lower lid and palpebral portion of the conjunctiva.

Microscopic examination.—The microscopic picture is typical, but varies with the age of the lesion. In the older lesions, where it may be impossible to demonstrate any casual organism, the tumours nevertheless present quite a characteristic histological picture.

In a section of a tumour from the glans penis it is seen that the epithelium is usually ulcerated about the summit of the growth. The ulcerated surface consists of ordinary granulation tissue, in which are many capillary blood vessels and a marked infiltration of the tissues with eosinophile leucocytes. At times caseous areas are seen on the ulcerated surface. At the edge of the ulceration the *stratum corneum* is seen to be slightly thickened, while the *rete mucosum* shows hypertrophic changes, anastomising processes dipping deeply into the *cutis vera*. The *rete mucosum* at this point is usually slightly infiltrated with eosinophile leucocytes. The epithelium covering the tumour in the other situations sometimes shows slight hypertrophic changes, but it is otherwise normal in appearance. The *cutis vera* is normal in these situations, except for

a slight invasion with eosinophiles. Immediately under the *cutis vera* the eosinophilic infiltration is seen to be very marked. The eosinophiles may be so numerous as to fill all the lymph spaces, leaving only a more or less fine connective tissue stroma supporting them. There is an increase in the small blood vessels with well-defined walls. There is hyperplasia of the fixed connective tissue cells. Roughly circular areas, consisting of embryonic connective tissue cells with some mononuclear leucocytes, but with few or no eosinophiles, are seen.

The caseous areas vary slightly in size; they have well-defined margins and take acid stains intensely. Tissue reaction round these areas appears to depend on their age. There is a proliferation of the fixed cells and commonly a marked epitheloid cell reaction with the formation of multinucleated cells. Sometimes there is a well-defined fibrous capsule. The nuclei of the cells within the areas show some pyknosis, and the chromatim remains for some considerable time. The protoplasm of the cells is apparently fused. All tissues are included in this necrosis, and the indistinct forms of blood vessels and connective tissue strands can be detected. In some of the areas a calcerous deposit may be seen. More or less in the centre of the necrotic areas are seen either circular or ovoid spaces containing *débris* and a few leucocytes. These represent the spaces at one time occupied by, and the remains of, a larval Nematode, and may appropriately be termed "worm canals." Larvae or *débris* are not found in all sections. This may be due either to the fact that the section does not necessarily cut that portion of the necrotic foci containing the larvae or to the complete disintegration of larvae or *débris*.

In some of the earlier lesions the larva is often to be seen distinctly. It is easy to demonstrate the clear, homogenous, finely-ridged cuticle, the musculature lying beneath, and the primitive alimentary canal. The section may be transverse, oblique, or longitudinal, and there may be more than one section of the larvae in a necrotic area. In one area seven transverse or oblique sections were seen. These probably represent as many individual larvae. For the most part, however, only one worm is seen in each necrotic area, and it is always more or less twisted and curved.

In other parts of the section the worm is found surrounded by only a small necrotic area. Often oblique and transverse sections of the worm are seen extending in a more or less regular line across the field of the microscope, representing the twisting and curving of one organism.

In some lesions examined many larvae have shown marked degeneration with a well-developed necrosis of the surrounding tissues, while other forms have been well preserved, and have caused little or no necrosis of the tissues. This suggests that, in some cases, the larvae have made their appearance in the tissues not by one massive invasion, but by smaller invasions repeated over a certain period of time. For the most part, however, all larvae in a given lesion appear to be in approximately the same state of preservation or disintegration. All the larvae seen in the different lesions examined have apparently been dead, but the retrogressive processes vary markedly in extent in different tumours.

In the older lesions it is not possible to determine the exact nature of the material contained in the circular or ovoid spaces in the necrotic areas, but in the light of the knowledge gained from examining earlier lesions, there can be no doubt that the material is the *débris* of a larval Nematode.

It must be insisted here that in the older lesions one may be unable to detect any degenerated larvae, or even the spaces which they at one time occupied. This fact renders it important that the histopathological picture in all its variations should be thoroughly studied and understood. If this is done a diagnosis can usually be made, in spite of the fact that no casual organism can be demonstrated.

The foregoing descriptions of the microscopic appearances apply equally to tumours from the penis and from the sheath, except that in the latter situation the tissue reaction is far more marked and the necrotic areas more diffusely scattered throughout the tumour. In both situations there may be marked endothelial proliferation in the intima of the arterioles. This is often seen in the deeper parts of the tumour. Sometimes there is thrombosis of the vessels. The necrotic areas, however, are in no way associated with the vascular changes, but are apparently due entirely to decomposition products originating in the degenerating larva.

The microscopic appearances of the lesion from the metacarpus vary somewhat from those described above. The tumour consists throughout of dense fibrous tissue, in which areas of embryonic connective tissue cells with an infiltration of mononuclear leucocytes appear as islands. These areas are usually somewhat circumscribed, and in some of them are found degenerated larvae with slight surrounding tissue necrosis and the formation of multinucleated cells. There is a diffuse infiltration of all the tissues with eosinophile leucocytes. There is little formation of new tissue apart from

the areas of hyperplastic connective tissue cells and some thickening of the dense subcutaneous connective tissue.

The following is the description of the microscopic appearances of the conjunctival lesions observed by Lewis and Seddon:—"From a study of the earliest lesions examined, *viz.*, those of Case I., the parasites appear to occur primarily in lymph spaces. Only odd parasites or portions (in section) are found apart from the necrotic material. The presence of the parasites gives rise to small-celled infiltration as a tissue reaction, followed by an aggregation of neutrophile leucocytes and eosinophiles followed by necrosis of cells. While necrosis is in progress around the parasites one finds at the periphery of the mass large fibrous tissue cells massing together along with giant cells. The tissue between the areas is composed of typical granulation tissue, with eosinophiles and proliferation of endothelial cells and fibroblasts. There is also in one section some ulceration of the epidermis and some warty condition of the epithelium similar to what is met with in other ulcerative conditions."

It will be seen from this description that the change is essentially the same as that described above, varying mainly in the degree of tissue reaction.

The larval Nematode.—On account of the difficulty of obtaining early lesions, few opportunities of minutely examining larvae have arisen. However, larvae have been separated out from the tissues, and most of the important characteristics have been determined.

The method has been to separate the small necrotic areas from the tissues of an early lesion. These have been softened with pepsin or trypsin, washed, then lightly crushed between two glass slides, dehydrated and cleared with carbol-absolute alcohol. By gently moving and pressing the cover-slip placed over the portion of crushed tissue, one has been successful in forcing the larva out of the canal it occupies. The larva has never been removed unbroken, but by piecing the broken portions together the main external characteristics have been clearly defined.

As far as can be judged the larva is approximately 3 mm. long by 40 μ to 53 μ broad. The anterior extremity tapers slightly at the head, which is rounded. The mouth is surrounded by thin prominent lips. The posterior extremity tapers and terminates in a pointed tail, which is rounded at the tip to form a small bulb furnished with minute spines. The anus opens at about 83 μ from the point of the tail. The tail is curved rather sharply backwards. There are apparently no transverse striations of the cuticle, but in sections fine longitudinal ridges are seen. These longitudinal ridges are

only seen in transverse sections of the larva. The internal anatomy of the larva has not been accurately determined. The oesophagus is long, and the intestine occupies the main part of the body cavity.

The description of the larva as found by Lewis and Seddon agrees closely with the above. They do not mention the occurrence of fine longitudinal ridges in the cuticle, but in the specimen shown the present writer by Mr. Seddon these longitudinal ridges were plainly to be seen. Their presence, as will be shown later, is of importance in the identification of the larva.

From the foregoing it will be seen that the worm is an immature Nematode, and that it closely resembles the sixth larval stage of *Habronema muscae* as described by Ransom (1913).

There is little or no direct evidence as to the mode of entry of the larvae. As *Habronema muscae* was the only species the life-history of which had been determined, it became necessary to determine the life-histories and morphology of the other two species of *Habronema* before it was possible to attempt to identify the species of larva responsible for the production of the lesions.

Observations on the life-histories of the three species of *Habronema* were therefore made, and these will be outlined before the mode of entry and specific identification of the larva are discussed.

Obsrvations on the Life-histories of the Three Species of *Habronema*.

Since Carter first described the présence of a Nematode worm in the head of a house-fly in 1861, many other workers have observed and recorded a similar occurrence.

Ransom (1913) has shown that the embryos of *Habronema muscae* are taken up by the larvae of *Musca domestica*, that they develop through larval stages in the fly larvae and pupae, and that the final larval stage of the worm is reached in the adult fly, and is usually found situated in the head and proboscis.

Linstow, in 1875, described a Nematode larva in the head of *Stomoxys calcitrans* which resembled the larvae found in *Musca domestica*, but which he named *Filaria stomoxeos*. Harvey Johnston (1912) recorded the finding of a larva resembling that of *H. muscae* in *Stomoxys calcitrans*, and a similar larva in *Musca vetustissima*.

Ransom expressed the opinion that the larvae found by Linstow and others in *Stomoxys calcitrans* might possibly be the larva of *Habronema microstoma*.

At the time of starting these experiments nothing more than the above was known of the life-histories of the three species of *Habronema* found commonly in the stomach of the horse.

In attempting to determine the species of the larva found in habronemic granulomata it became necessary to learn more of the life-histories of the three species of *Habronema*. In the latter part of 1916 experiments were started with this end in view, and also to obtain material for animal experimentation. The experiments had gone to show that under artificial conditions both *Habronema muscae* and *H. megastoma* develop through their larval stages in *Musca domestica*. At that time it was not possible to take the experiments any further.

Towards the end of 1917 the work was taken up again, when it was found impossible to pass *H. megastoma* through *Stomoxys calcitrans*. The work was proceeding when it was learned that Hill, working at the Melbourne University Veterinary School, had confirmed the above findings, and had found, further, that *Habronema microstoma* developed through its larval stages in *Stomoxys calcitrans* and rarely in *Musca domestica*, while *Habronema muscae* showed no development in *S. calcitrans*. Nothing further of Hill's work has been learned, and up to the time of writing (March, 1919) his work has not been published.

The experiments were continued during 1918 and the early part of 1919.

Method.—For the purpose of obtaining embryos, stomachs taken from horses killed at the Zoological Gardens, Adelaide, were examined. In all, considerably over one hundred stomachs were examined.

In the preliminary experiments carried out in 1916 stomach contents showing numerous embryos of *Habronema muscae*, and in which no other species were found, were mixed with horse-dung and exposed in the stables for about two hours to allow flies to deposit their eggs thereon. The dung used in the experiments was previously found to be free from embryos capable of developing in *Musca domestica*. Dung from the same animal was used in experiments with *Habronema megastoma*, and the contents of the submucous tumours were used to supply the embryos.

In the later experiments sterilized dung was used, and the embryos were obtained from the gravid female after specific identification. In the case of experiments with *Habronema megastoma*, embryos were also obtained by collecting the contents of the submucous tumours after these had been thoroughly scraped and washed in running water for

several hours, only the contents from the deeper portions of the tumours being used.

For the purposes of the experiments both *Musca domestica* and *Stomoxys calcitrans* were bred artificially and the cultures kept going in the laboratory.

The culture of *Stomoxys calcitrans* was kept going for twelve months, when it was allowed to die out. The flies maintained their vigour and size throughout this period. They were fed daily on a rabbit, and were allowed to deposit their eggs on fermenting lawn clippings taken from a lawn where contamination by horse-dung was excluded.

Musca domestica was fed on a mixture of horse serum, sugar, and water, and was allowed to deposit its eggs on sterilized horse-dung. It was found most convenient to use these artificial cultures of the flies, for in this way experiments could be made during that time of the year when specimens are difficult to obtain in the field, and also, the number of fly larvae developing in a given culture could be more easily regulated. As in most of the experiments an attempt was made to obtain flies heavily infested with larvae, it was important to regulate the number of fly larvae developing in a culture.

The stomachs were sometimes examined a few hours after removal, but for the most part not until twenty-four hours, and sometimes as long as forty-eight hours, after removal. The worms were always found to be alive and active, although in those collected from stomachs examined from twenty-four to forty-eight hours after removal, activity had considerably decreased. This loss of activity was an advantage when specimens had to be examined microscopically. Only on one or two occasions was a stomach found in which no worms could be detected. A complete examination for the presence of all possible species was not made, but a rough idea was usually obtained of the number of species present. Only in one case was *Habronema microstoma* found to be present in very large numbers without any other species. It was found to be more commonly present than was at first expected, and in most of the stomachs examined could be found, although often only very few specimens were present. *Habronema muscae* was found to be present in most of the stomachs examined, and usually in large numbers. This worm was found to be more closely associated with the mucous membrane than *Habronema microstoma*, and quite commonly the head of the parasite was buried in the gastric glands. This parasite is usually orange-coloured, and sometimes more red, suggesting the presence of blood in the body of the worm. Chemical tests for blood were obtained with extracts from these worms.

Habronema megastoma was found to be of infrequent occurrence, and less commonly met with than the other species. Sometimes one would obtain two or three stomachs consecutively which contained *H. megastoma*, and then many stomachs would be examined before obtaining another specimen. It was not until after a large number of stomachs had been examined that it became obvious that *H. megastoma* was more rarely met with than *H. microstoma*, *H. muscae* being the most common, and usually found in each stomach examined.

For the purposes of the subject under investigation it was considered that any detailed study of the adult forms was unlikely to give any useful information.

No detailed study of the development of the worm larvae in the fly larvae, pupae, and adults was made, as, of necessity, a limit had to be placed on the scope of the investigation.

The following is a brief outline of the observations made on the embryos and larvae of the three species of *Habronema* and examination of adult flies:—

THE LIFE-HISTORY OF *Habronema muscae* (Carter, 1861).

Ransom has already shown that embryos of *Habronema muscae*, passed along with the faeces of the horse, gain entrance to the larvae of *Musca domestica*, probably through being swallowed by the fly larvae. The embryos gain the body cavity, where they pass through their larval stages, and have usually reached the final larval stage (sixth stage of Ransom) at or soon after the hatching of the adult fly. This final larval stage was the first stage to be observed in the stomach of the horse.

Ransom's work consisted mainly in the examination of adult flies, pupae, and larvae for the presence of larvae of *Habronema*. He assumed that all larvae found in the head and proboscis of adult flies were larvae of *Habronema muscae*. It is possible, however, that some of the specimens he observed may have been larvae of *Habronema megastoma*.

The experiments undertaken in 1916 under artificial conditions confirmed Ransom's conclusions.

Embryos of H. muscae.—Embryos that have been passed out from the female have been found to be enclosed in a thin shell which is closely applied to the body except at the posterior end, where it is distinctly seen held away by the curved tail. The embryos are only slightly motile. They measure from 80 μ in length by 12 μ in width to 110 μ in length by 6·6 μ in width. When these embryos are collected from the stomach contents or from the gravid female and placed in saline they live for many days, depending on

light, temperature, and bacterial growth. They rarely show any tendency to leave the shells. When placed in tap water the majority of the embryos are found to be free in twenty-four hours.

Adult flies.—At first the observations were confined to the study of the development of *H. muscae* in *Musca domestica*. In the preliminary experiments it was found that approximately 100 per cent. of the flies hatching out showed larvae situated, almost invariably, in the head and proboscis. These larvae were found to resemble the sixth larval stage of *H. muscae*, as described by Ransom. As many as eight larvae were found in the head and proboscis of one fly.

In the later experiments the examination of flies that had just hatched often showed the presence of larvae in an early stage of development, measuring approximately 400 μ long, and being situated in the abdomen, and usually encysted. In from five to seven days these larvae were found to have developed into the final larval stage, and to have migrated to the head and proboscis. As many as from thirty to forty larvae have been found in the head and proboscis of these flies.

For the most part larvae found in the head and proboscis have been of the final larval stage of development, but occasionally larvae of an earlier stage of development have been found along with those in the final stage.

The flies often showed a marked paralysis of the proboscis, although they were still able to feed.

The time occupied in development from the deposit of the eggs to the hatching of the adult flies was usually from fourteen to eighteen days.

Flies bred in sterilized horse-dung, with which had been mixed an emulsion of embryos in normal saline solution, usually showed the presence of larvae in the great majority of those hatching out. On three occasions, however, no larvae were present in any of the flies hatching out. On two of these occasions the emulsion of embryos was made in tap water, and on one occasion in saline solution. On each of these occasions the eggs were obtained from flies caught in the laboratory. There was never any failure of development of larvae in the strain of *Musca domestica* kept going by artificial cultivation.

All attempts to obtain any development of embryos of *H. muscae* in *Stomoxys calcitrans* failed.

Larvae of H. muscae.—Attention was practically confined to the study of the final larval stage. These larvae obtained from the head and proboscis of flies were found to measure from 2·58 mm. to 2·87 mm. long, the majority measuring 2·7 mm. The maximum width was found to vary from 50 μ to 66·6 μ. The head was rounded and the body tapered slightly

from about the posterior part of the oesophagus. The tail was pointed and possessed a small rounded tip furnished with minute spines. The anus was open and situated 83·3 μ from the point of the tail. The pharynx was 43·3 μ long; the nerve ring 130 μ from the anterior end of the body, and the anterior portion of the oesophagus 133 μ to 140 μ long.

The larvae were embedded in paraffin and sectioned. On transverse section the cuticle was found to be traversed by fine longitudinal ridges. These numbered from forty to forty-two, as near as could be determined; started immediately behind the head and ended near the tail.

Experiments were undertaken to determine the power of the larvae to leave the proboscis of the fly. Flies were placed in an inverted wide-mouthed Florence flask. The mouth of the flask was surrounded by gauze, which also surrounded the mouth of a test tube situated several inches below and containing sugar dissolved in water. This test tube was kept filled with the solution, which was examined from time to time for the presence of larvae. The flies drank freely of the solution, but at no time were any larvae found to have escaped into the solution.

In one case two flies kept overnight in a test tube containing a small amount of sugar solution were found to be dead the following morning. Two active larvae were found in the solution. It is not possible to say whether the larvae left the proboscis during the life of the fly or after its death. Dead flies have been placed in saline solution, and later larvae have been found in the solution.

In making a careful removal of the proboscis from the head it has sometimes been observed that the larvae will escape through the lips of the proboscis. This is probably due to rupture of the proboscis during handling rendering it possible for the larvae to escape from their situation in the muscular portion into the food canal.

Experiments were made to determine whether larvae are capable of penetrating filter paper. A short test tube was filled with saline solution, or a mixture of saline and horse serum, and a folded filter paper (very small size) was fitted into the mouth of the tube. Larvae were placed in the fluid contained in the cup formed by the folded paper. This preparation was kept at room temperature or 37° C. for twenty-four hours in a moist chamber, and the fluid in the test tube examined for the presence of larvae. On one occasion two larvae were found in the fluid. This finding could not be confirmed after repeated experiments.

The larvae were found to remain alive in saline solution or horse serum for forty-eight hours, and sometimes up to seventy-two hours.

Larvae were found to remain alive in the bodies of dead flies for several days if loss of moisture was prevented.

The Life-history of *Habronema megastoma* (Rudolphi, 1819).

The methods adopted in this investigation have already been mentioned. The embryos were sometimes obtained from the contents of the submucous tumours and sometimes from the gravid female.

Embryos of H. megastoma.—The embryos are enclosed in a thin shell or membrane. They are doubled on themselves in the shape of the letter U, the tail coming to lie close to the head. The shell measures from 43·3 μ to 53·3 μ long by 11·6 μ to 13·3 μ wide. The widest portion of the embryo measures 6·6 μ.

The embryos when placed in saline solution and tap water behave in the same way as those of *H. muscae.* When they do break away from the shell they remain bent in the shape of the letter V or the letter L. They are only very slightly motile. When taken from the gravid female the shell is less resistant than in those born under natural conditions. This has been found true of the embryos of all three species.

Adult Flies.—In the main the results of the observations were the same as in the case of flies infested with the larvae of *Habronema muscae.* The rate of development of the larvae appeared to depend upon the temperature at which the culture was kept. During the warmer weather flies hatching out often showed larvae at or near the final stage of development. At other times larvae were found in a very early stage of development. In one case flies hatching out in seventeen days showed larvae measuring from 272·7 μ to 409 μ in length. These larvae were present in the abdomen, and the majority were encysted. From four to five days later these larvae had developed into the final larval stage. The atmospheric temperature was high during this latter period. When the final larval stage was reached few or no larvae remained in the abdomen, but migrated to the head and proboscis. Many of the flies died suddenly, probably through injury to the central nervous system by the migrating larvae. The parasitism was very heavy, from fifty to sixty larvae being present in a single fly. The proboscides of many of the flies were seen to be paralyzed. When these flies were examined some days later the larvae were found to be less active than when first making their appearance in the head and proboscis.

It has been observed that if flies die when the larvae are in an early stage of development these larvae quickly die, but if the final larval stage has been reached the larvae live for

two or three days, provided that desiccation is prevented.

Larvae in an earlier stage of development have at times been found in the proboscis along with larvae in the final stage of development.

Failure to produce an infestation of flies occurred in exactly parallel circumstances as in the case of the experiments with *Habronema muscae*.

All attempts to obtain any development of embryos of *Habronema megastoma* in *Stomoxys calcitrans* failed.

Larvae of H. megastoma.—Larvae obtained from the head and proboscis of flies were found to measure from 2·07 mm. to 2·5 mm. long by 60 μ to 66·6 μ wide. The larvae had the same general appearance as those of *H. muscae*, but in a few specimens a circular ridge posterior to the lips was observed. The pharynx was 60 μ long; the nerve ring 116·6 μ to 126·6 μ from the anterior end of the body, and the anterior portion of the oesophagus 80 μ to 90 μ long. The anus was open and situated from 80 μ to 90 μ from the tip of the tail, which was pointed, and possessed a small rounded tip furnished with minute spines. On transverse section the cuticle was found to possess fine longitudinal ridges to the number of 40 or 42, as near as could be determined.

Observations on the power of the larvae to leave the proboscis of the fly gave the same results as those given in the case of *H. muscae*.

Experiments made to determine the power of the larvae to penetrate filter paper gave negative results.

The Life-history of *Habronema microstoma* (Schneider, 1866).

The methods adopted at this investigation have already been mentioned. The embryos were obtained from the gravid female. Fermenting lawn clippings were used as a breeding ground for *Stomoxys calcitrans*, and an emulsion of the embryos in saline solution was added to this material.

Embryos of H. microstoma.—The embryos when taken from the gravid female are usually very active, and they remain active for some days in normal saline solution. They measure from 90·9 μ to 122·8 μ in length, and are enclosed in a thin shell or membrane. When placed in saline solution and tap water, respectively, they behave in the same way as those of *H. muscae*.

The embryos may live for some days when passed out naturally with the faeces of a horse. The faeces of a horse were previously examined, and found to contain embryos of *H. microstoma*. These faeces were kept for ten days, and then *Stomoxys calcitrans* allowed to deposit its eggs on the

material. Flies hatching out from eighteen to nineteen days later contained larvae.

Adult flies.—The rate of development of the worm larvae within the developing larvae and pupae of *Stomoxys calcitrans* appears to depend largely upon temperature. Flies bred at a low temperature, 20° to 22° C., and taking about thirty days to hatch out, show larvae in the earlier stages of development situated usually in the abdomen. Flies bred at a higher temperature, 25° to 26° C., develop more quickly, from seventeen to twenty days, and when hatching out show larvae in the final stage of development, mostly situated in the head and proboscis, with only a few in the abdomen. Those larvae situated in the abdomen are usually in an earlier stage of development.

If larvae in the final stage of development are found in the proboscis of newly-hatched flies, when flies of the same batch are examined a week to ten days later the larvae present are often dead.

If the development of the fly larvae has been delayed it is noticed that when the adult fly hatches out many dead and degenerating worm larvae are present. This was noticed, for example, in a culture in which the fly larvae developed quickly and the adult flies hatched out in from seventeen to twenty days. Some of the fly larvae, however, developed more slowly, and the adult flies hatched out in from thirty to thirty-four days. It was in these flies hatching out later that dead and degenerating worm larvae were found.

For the most part, newly-hatched flies showed larvae in the earlier stages of development situated in the abdomen. These larvae developed into the final stage in from five to seven days, and migrated to the head and proboscis. Larvae in an earlier stage of development have at times been found in the proboscis along with larvae in the final stage of development. The larvae were situated in the muscular portion of the bulb of the proboscis, and numbered from thirty to forty.

At no time did one fail to produce an infestation of *Stomoxys calcitrans* with larvae of *H. microstoma.*

Attempts to produce an infestation in *Musca domestica* usually gave negative results, but in one case there was an aberrant development of larvae of *H. microstoma* in *M. domestica.* In this case many of the flies examined showed embryos and larvae in varying stages of development. The development was distinctly aberrant, the larvae presenting appearances very different from those seen in *Stomoxys calcitrans.* Many of the forms present resembled embryos just escaped from the egg-membrane, only were somewhat longer. None of the embryos developed into the thick, nucleated larvae as seen in the normal development. The longer forms were

all dead and degenerating. The measurements of some of these longer forms were 151·5 μ, 318 μ, and 424 μ long respectively. Unfortunately, the preparations were lost through an accident before a more complete examination could be made.

The subject was not pursued any further, for at the time it was thought that it had little bearing on the matter under investigation.

Larvae of H. microstoma.—Larvae obtained from the head and proboscis of *Stomoxys calcitrans* were found to be distinctly shorter than the larvae of the other two species. They measured from 1·5 mm. to 2 mm. in length by 41 μ to 58 μ wide. The larvae had the same general appearances as those of the other two species. The pharynx was 43·3 μ long; the nerve ring was 110 μ from the anterior end of the body, and the anterior portion of the oesophagus was 116·6 μ long. The anus was open and situated 66·6 μ from the tip of the tail, which was pointed, and possessed a small rounded tip furnished with minute spines. On transverse section the cuticle was found to be homogenous and smooth, lacking all appearance of longitudinal ridges.

Observations on the power of the larvae to leave the proboscis of the fly gave the same results as those obtained in the case of the other two species.

The following observation made during the winter is of interest.—Proboscides were removed at the bend just posterior to the bulb. These were placed in saline solution in sealed chambers. One set was left at room temperature, 20° C., for one hour, and when examined no larvae had left the proboscis. Another set was placed in the incubator at 37° C. for one hour. When examined the saline solution contained many extremely active larvae. The first set which had been left at room temperature was then placed in the incubator at 37° C. for one hour. On examination the saline solution was found to contain extremely active larvae. The proboscides were then examined, and only an occasional larvae was found to have been unable to leave the proboscis.

Experiments made to determine the power of the larvae to penetrate filter paper gave negative results.

Summary and Discussion of the Salient Observations.

Habronema muscae was found to pass through its larval stages in *Musca domestica*, but showed no development in *Stomoxys calcitrans*. *H. megastoma* was found to possess a similar life-history.

H. microstoma was found to pass through its larval stages in *S. calcitrans*, and show sometimes an aberrant development in *M. domestica*.

The larvae of *H. muscae* and *H. megastoma* were found to possess very similar appearances. *H. megastoma* was usually slightly shorter than *H. muscae*, possessed a longer pharynx and a shorter anterior oesophagus, and the nerve ring was situated nearer the anterior end than in *H. muscae*. Both species of larvae possessed longitudinal ridges in the cuticle.

It is doubtful if these small differences in the appearances of the two larvae would prove sufficient for the purpose of differentiating larvae taken from granulomata, as in this case the larvae usually show some retrogressive changes and examination is more difficult.

Larvae of *H. microstoma* were found to be shorter than the larvae of the other two species, and the absence of longitudinal ridges in the cuticle offers a means for absolute differentiation between this larvae and those of the other two species.

Escape of the larvae from the proboscis of flies was found to depend upon rupture of some portion of the organ, probably the thinner citinous membrane on the interior surface of the labium. When this rupture was produced artificially the larvae rapidly made their escape into any moisture at hand, provided the temperature was sufficient to produce activity in the larvae. The escape of larvae from the proboscis under natural conditions was not demonstrated.

The larvae when developed into the final stage migrated to the head and proboscis. This may suggest that the larvae abandon the intermediate host in somewhat the same manner as Filaria larva do, but observations do not lend support to this suggestion. The migration to and situation in the proboscis of flies seems to be a common feature in the development of Nematodes. For example, Patton and Cragg (1913) have observed the development of the embryos of a species of *Oxyuris* in *Musca nebulo*. The embryos are ingested by the fly larvae, and the worms undergo their evolution in the pupae. When the flies hatch out they are infested with adult parasites, which cause paralysis of the proboscis on account of their accumulation in this situation.

The larvae apparently do not possess the power of penetrating the structures in the proboscis of flies. Rupture of the proboscis appears to depend upon the pressure exerted by the larvae, which pressure would be in direct proportion to the number of larvae present and their activity. Nor do the larvae appear to be capable of penetrating other objects such as filter paper.

Larvae do not appear to live in saline solution, horse serum, or water for longer than two or three days, and rarely as long as seven days. The longevity of the larvae outside the

body of the fly may depend to some extent on the period of time elapsing between their development into the final stage and their escape or removal from the proboscis.

Observations on the worm embryos suggest that these normally do not leave the egg-membrane, and their *rôle* is a passive one.

ANIMAL EXPERIMENTATION.

Preliminary experiments carried out in 1916 and 1917 with the final larval stage of both *Habronema musca* and *H. megastoma* had proved somewhat disappointing. The object of the experiment was to determine if possible which species of larva was responsible for the production of the granulomata. As the escape of the larvae from the proboscis of the fly appeared to be largely a matter of chance, it was decided to inoculate the larvae into the subcutaneous tissues of an animal. The larvae were obtained by dissection of the heads and proboscides of flies, and placed in a sealed pipette held vertically and filled with normal saline solution. When the larvae had gravitated to the end of the column of saline at the capillary end of the pipette the saline was removed, except for a small drop which contained the larvae. An incision was made through the skin of a horse and the larvae inoculated into the subcutaneous tissues. In each case a very small granuloma resulted, which on microscopic examination showed an infiltration of the tissues with eosinophiles, some hyperplasia of the fixed cells, and the formation of multinucleated cells. No necrotic areas were produced.

It was conceivable that keeping the larvae in saline solution for one or two hours before inoculation had rendered them more vulnerable to the activity of the tissue cells and fluids, and that their more rapid destruction in the body had prevented the occurrence of necrosis. In later experiments larvae were either allowed to escape from the proboscis directly into the tissues of experimental animals, or a mixture of equal parts of normal serum and saline was used as a medium of inoculation. The larvae were only allowed to remain in this fluid for about thirty minutes before being used.

The preliminary experiments made in the latter part of 1916 and the early part of 1917 were seven in number, and the animal used was the one designated as *pony* in the later experiments outlined below. These preliminary experiments were made as follows:—

Experiments with *Habronéma muscae*:—

(1) Embryos of *H. muscae* were placed in moist sawdust and the mass applied to the shaved skin of a horse.

(2) Six larvae from the proboscis of a fly were placed on the shaved skin of the animal, the site being moistened with saline solution.

(3) Four larvae were placed in the conjunctival sac.

(4) Seven or eight larvae were placed beneath the skin of the animal.

(5) Experiment (4) repeated.

(6) Experiment (4) repeated on a rabbit.

Results.—No evidence was obtained suggesting that the embryos or larvae were capable of penetrating the skin. There was no evidence of any change in the tissues of the conjunctival sac following the instillation of the larvae. A slight induration was produced at the site of inoculation of the larvae. One area was removed, and the microscopic examination revealed the changes in the tissues mentioned above. No change was produced in the tissues of the rabbit following inoculation.

Experiments with *Habronema megastoma*:—

Only one experiment was made. In this larvae were placed beneath the skin, as in experiments with *H. muscae*. The tissue reaction was the same in this case as with *H. muscae*.

In the following experiments two animals were used throughout. For the purpose of identification one will be called *pony* and the other *mare*.

1. Experiments with *H. microstoma*:—

(a) Feeding experiments with *Stomoxys calcitrans*—

Flies heavily infested with larvae were placed in a flask, the mouth of which was covered with gauze. These flies were placed on a shaved area of the skin of the *mare*, and held in position for about one hour. These experiments were made in the month of June, 1918, the weather being cool. The flies did not bite very readily. After the feeding operations the site was seen to be somewhat swollen, which swelling had increased slightly by the following morning, but rapidly disappeared during the day. Another site was selected, and the experiment repeated on the following day with the same results.

The experiment was repeated on the *pony* with the same results.

Some months later, December, flies were placed in a cage which was placed over a shaved area of the skin of the *mare* and kept in apposition for two hours by means of bandages. This experiment gave the same result as the previous experiments.

The result of the experiments was a complete failure to produce a granuloma by this method.

It was observed that the proboscides of many of the flies were paralyzed, and that the flies had to a great extent lost their desire and ability to bite. They fed more readily on a rabbit, but not so readily as the normal flies.

(b) Larvae placed in the skin of the horse—

It was observed that when the proboscis was removed from a fly and placed in normal saline solution kept at 37° C., the larvae rapidly left the proboscis.

It was decided to determine the ability of the larvae to penetrate the subcutaneous tissues of the horse. Two small incisions were made in the skin of the *mare*. The incision was not so deep as to pass right through the *corium*. Two proboscides were placed in each wound. The edges of the wound were drawn together by means of adhesive plaster. The following morning,

about twenty hours later, the proboscides were removed and the wound again protected by a covering of adhesive plaster. There was a marked swelling around each wound and a collection of pus in the wound. The purulent discharge completely disappeared twenty-four hours after the removal of the proboscides, but the tumefaction of the tissues persisted. In seven days' time a hard granuloma about twice the size of a pea was present at each site. One site was removed for microscopic examination, and the other left for further observation. Microscopic examination showed marked infiltration of the tissues with eosinophiles, hyperplasia of the fixed cells, and the formation of multi-nucleated cells. Only one necrotic area was detected, but no larvae could be seen associated with this. No larvae could be found in any of the sections made. The other area left for further observation gradually disappeared.

This experiment was repeated in every detail on the *pony*. Two small granulomata resulted. One removed twelve days after inoculation showed the same histological picture as the one from the *mare*, but no necrotic areas or larvae were detected in any of the sections.

These experiments were carried out during September, when the weather had become warmer.

As the leaving of the proboscides in the wound for twenty hours had produced a purulent discharge, it was decided to considerably reduce this time in future experiments.

About six weeks later four proboscides were placed in a wound in the skin of the *mare*. These were removed from five to six hours later. There was a marked swelling present, the area having a diameter of 4 cm. The tissues were very tense, and there was some blood-stained exudation from the wound. The swelling increased during the next twenty-four hours, but in another twenty-four hours it was much reduced. Seventy-two hours after inoculation only a slght thickening was detected. The site was removed for microscopic examination. In sections the larvae were found to have penetrated the tissues for some distance from the line of incision in the skin. They were surrounded by leucocytes, the nuclei of which showed fragmentation and pyknosis. There was oedema of the tissues, accumulation of leucocytes in small areas and around the blood vessels. There was infiltration of the tissues with eosinophiles.

During December the same experiment was repeated on the *pony*. Two wounds were each inoculated with three proboscides, which were removed six hours later. One site was removed six hours after inoculation. Microscopic examination showed that there was dilatation of the vessels with oedema of the tissues. The tissues were infiltrated with polymorphs and eosinophiles. Larvae were found some distance from the site of inoculation and surrounded by leucocytes.

The other area was removed ten days after inoculation. There was present a hard nodule about the size of a Barcelona nut. Microscopic examination showed the usual inflammatory reaction with giant-cell formation. There were a few necrotic areas present, with which were associated degenerating larvae.

(c) Larvae placed on a scarified area of skin—

An area of the skin of the *pony* was lightly scarified, and two proboscides placed on the moist surface. The experiment gave a completely negative result, healing taking place without any tumefaction of the tissues.

Several attempts were made to inoculate the larvae beneath the skin by means of a hypodermic needle and syringe. It was found to be difficult or impossible to determine whether the larvae had been successfully inoculated, and as only a fleeting infiltration of the tissues occurred after inoculation, the method was abandoned.

2. Experiments with *H. muscae*:—

(a) Larvae placed in the skin of the horse—

Six proboscides of *Musca domestica* heavily infested with larvae were placed in an incision in the skin of the *mare*, and removed five to six hours later. Tumefaction of the tissues was produced, which increased during the twenty-four hours after inoculation, and then gradually subsided. About a week later a swelling about the size of a Barcelona nut was present. This rapidly reduced in size and completely disappeared.

The day following the first inoculation another inoculation was made with the same results as the first.

Some days later three more inoculations were made. After the primary tumefaction of the tissues had disappeared in from twenty-four to forty-eight hours no abnormality could be detected.

These experiments were repeated on the *pony*. In all, three inoculations were made. Only a slight primary tumefaction of the tissues resulted which disappeared in about thirty-six hours, leaving only a very slight thickening, which completely disappeared in from fourteen to twenty-one days.

(b) Larvae added to the conjunctival sac—

About the same time as the above experiments were made larvae were placed in a pipette containing a mixture of equal parts of normal horse serum and normal saline solution. The larvae were then added along with a small quantity of the mixture to the conjunctival sac (off side) of the *mare*. The conjunctiva remained normal in appearance, and no excessive lacrymation was produced.

The experiment was repeated on the *pony*. The following morning a slightly excessive lacrymation was present, which, however, disappeared during the next twenty-four hours. The conjunctiva remained normal in appearance.

(c) Larvae placed on a scarified area of skin—

An area of the skin of the *mare* was lightly scarified, and the proboscides placed on the moist surface, and kept in place by the aid of adhesive plaster. The tissues showed very slight tumefaction twenty-four hours later, which rapidly disappeared.

This experiment was repeated with the same result.

It was also repeated on the *pony*, and no reaction was produced.

(d) Larvae placed on a moistened area of skin—

A shaved area of the skin of the *mare* was moistened with the serum and saline mixture, and a proboscis containing larvae placed on this. The following morning there was the merest suggestion of an elevation in the skin, but it was not observed the following evening. This experiment was repeated with the same result.

There was no reaction produced in the tissues to suggest that the larvae has penetrated the skin.

3. Experiments with *H. megastoma*:—

(*a*) Larvae placed in the skin of the horse—

Proboscides of *Musca domestica* heavily infested with larvae were placed in three incisions in the skin of the *mare* and removed from five to six hours later, when there was present a marked inflammatory oedema of the tissues. One area was removed five hours after inoculation for the purpose of microscopic examination. Larvae were found to have made their way into the subcutaneous tissues, where leucocytes had commenced to surround them.

The other two sites were left for further observation. After inoculation the primary tumefaction reached a maximum in about forty-eight hours, and had a diameter of from 6 to 7 cm. This gradually subsided, and in nine days' time one site was removed, when there was present a granuloma about the size of a small walnut. Microscopic examination showed an intense infiltration of the tissues with eosinophiles, hyperplasia of the fixed cells, the formation of multinucleated cells, and the presence of necrotic areas containing degenerating larvae.

The other granuloma persisted for about three weeks, when it gradually disappeared.

The experiments were repeated on the *pony*. Proboscides were placed in three incisions in the skin and removed from five to six hours later, when there was marked inflammatory oedema of the tissues. This increased during the next twenty-four hours, but had very much decreased in forty-eight hours after inoculation.

One area was removed six hours after inoculation. Microscopic examination showed that the larvae had made their way into the subcutaneous tissues, where they were surrounded by leucocytes.

The other two areas were left for further observation. In forty-eight hours after inoculation the swelling had almost disappeared, and in three or four days' time there was little or no thickening of the tissues.

(*b*) Larvae added to the conjunctival sac—

Larvae were added to the conjunctival sac (near side) of the *mare*. Twenty-four hours later no reaction had been produced. In three or four days' time excessive lacrymation was present. In a further three days the conjunctiva was injected and somewhat swollen. Small yellowish "tubercles" were to be seen on the membrana. These persisted for over a week, but in a fortnight's time had entirely disappeared. Epiphora continued, however, for about six weeks.

The experiment was repeated on the *pony* with exactly the same results.

(*c*) Larvae placed on a scarified area of skin—

Larvae were placed on three scarified areas of the skin of the *mare*. Larvae were added to one of the scarified areas on three consecutive days. In no case was any reaction produced.

This experiment was repeated on the *pony*, two scarified areas being made. No reaction was produced.

(*d*) Larvae placed on a moistened area of skin—

Larvae were placed on two moistened areas of the skin of the *mare*. No reaction was produced.

The experiment was repeated on two areas of the skin of the *pony* with the same result.

4. Experiments with embryos:—

Embryos of the three species kept in saline and tap water, respectively, were added to sterilized horse-dung or sawdust and placed on shaved areas of the skin of the two horses.

In no case was any reaction produced in the skin of the animals.

5. Summary and discussion of the experiments:—

Experiments have shown that larvae of *H. microstoma* are capable of making their way into the subcutaneous tissues of the horse through an incised wound in the skin. A certain number of these larvae appear to be rapidly destroyed and removed by phagocytes. Others are not so rapidly destroyed, when they produce a necrosis of the surrounding tissue and cells. As the larvae disappear they do not appear to leave any worm canals in the necrotic areas. In the experiments a tissue reaction was produced which is essentially the same as that seen in granulomata occurring under natural conditions. No granulomata were produced after allowing flies to bite the horse. When larvae were added to a lightly scarified area of skin they appeared to be incapable of penetrating the tissues; at least no tissue reaction which might suggest such a penetration was produced.

Larvae of *H. muscae* possessed the power of making their way into the subcutaneous tissues, but only a very slight tissue reaction was produced, and this quickly disappeared. When they were added to the conjunctival sac they produced no reaction. The larvae did not appear to be capable of penetrating the lightly scarified skin, nor the moistened, uninjured skin.

Larvae of *H. megastoma* produced a typical granuloma in one animal, but failed to produce the same reaction in the other animal. The microscopic appearances of the granulomata produced were exactly similar to those seen in lesions occurring under natural conditions. Those larvae that were not rapidly destroyed and removed produced typical necrotic areas in which the degenerating larvae persisted for some time, and after their disappearance very definite worm canals were produced. The lesion, however, did not possess a marked chronicity. The larvae produced a conjunctivitis in both animals. They did not appear to be capable of penetrating the moistened or scarified skin.

The granulomata produced with larvae of both *H. microstoma* and *H. megastoma* were comparatively small, and showed little chronicity. Likewise, the conjunctivitis produced by the larvae of *H. megastoma* was not of a very severe character. The larvae of *H. megastoma*, when they produced a granuloma, appeared to be better preserved than those of

H. microstoma found in the granulomata produced by the latter.

Under the conditions of the experiment the embryos of all three species appeared to be incapable of penetrating the skin of the horse.

In these later experiments the results obtained in the preliminary experiments were confirmed, *viz.*, larvae of *H. muscae* produced no conjunctivitis and no typical granuloma in the skin, and the larvae of *H. megastoma* produced no typical granuloma in the skin of the *pony*.

The experiments have shown that the larvae of all three species are capable of making their way into the subcutaneous tissues when the injury in the skin has been deep enough to include the *corium*. This migration in the tissues is probably assisted by the oedema present. The larvae, however, do not migrate for any great distance from the point of entry, in the experiments only up to about 1 cm. The larvae do not appear to be able to penetrate the tissues when the injury is confined to the superficial epithelium.

Considering the number of larvae inoculated, the number of necrotic areas produced was small. This appears to be explained by the probable escape of some of the larvae, but more particularly by the early destruction of some of the larvae. Tissues removed from five to six hours after inoculation with larvae have shown the larvae surrounded by neutrophile leucocytes, which attack and apparently quickly remove them. Some of the larvae, however, appear to offer more resistance or attract few or no neutrophile leucocytes. These neutrophile leucocytes are not found in the tissues removed from five to seven days after inoculation. The fact that certain larvae of the same species appear to offer more resistance to the attack of neutrophile leucocytes, or show less positive chemotaxis, leads one to expect that certain strains or varieties of the same species would be more likely to produce granulomata under natural conditions.

Discussion.

That these larval Nematodes are the cause of the granulomatous reaction there appears to be no possible doubt.

Microscopical examination demonstrates that the larvae soon after their introduction undergo degenerative changes. There results an infiltration of the tissues with eosinophile leucocytes and some proliferation of the fixed cells. Mononuclear leucocytes are also attracted to the site. These changes cause a tumefaction of the tissues which later usually gives rise to a pressure necrosis in the skin or mucous membrane. As the degenerative changes in the larvae progress

there results a necrosis of the tissues in their immediate vicinity, giving rise to the typical caseous areas.

These changes represent the characteristic appearances of the granuloma, and, apart from bacterial infection of the ulcerated surface, there is no reaction present which would not be produced by the presence and degeneration of the larval Nematode.

This evidence is almost sufficient to prove that the larvae are the essential cause of the granuloma, and that they cannot be regarded as an epi-phenomenon. Added to this evidence is the failure to demonstrate by any conceivable method the presence of any bacterium, mould, or protozoon, except a mixed variety of bacteria on the ulcerated surface.

Experimentally it has been shown that larvae of *Habronema* are capable of producing a granuloma very similar to that found under natural conditions. This fact, taken with the above evidence, is sufficient to prove that the presence of the larvae in the cutaneous, subcutaneous, or submucous tissues is the essential cause of the lesion.

It is interesting to note that there is no essential difference between the tissue reactions seen in these tumours and those seen about many of the caseous areas to be found commonly in the internal organs of most herbiverous animals.

The fact that, although the larvae die out soon after the first appearance of the lesion, the tumour goes on enlarging, and may exist for some considerable time, is of extreme interest.

This gradual enlargement of the tumour consists of an enlargement of the necrotic areas and an increased tissue production. There is no increase in the number of foci as, for example, occurs in actinomycotic granulomata, except in the case of re-infection or super-infection.

The growth of the tumour is due mainly to the fact that the substances which originate in the degenerating or autolysing larvae, and which apparently causes the death of the tissue cells, very slowly penetrate to the outside of the necrotic tissue, and thus cause a slow but gradual enlargement or extension of the necrosis. This, of course, is limited, and the maximum amount of necrosis is produced in a certain time, according to various conditions which are difficult to measure.

Once the larva becomes surrounded by necrotic tissue, the diffusion outwards of the autolytic products is impeded. The autolytic products would, therefore, become concentrated towards the centre of the necrotic area, and their slow diffusion to the outside would tend to produce a gradual extension of the necrosis, even after the complete disappearance of the larva. The continued presence and enlargement of the

necrotic areas would produce a corresponding tissue reaction, and so the tumour would continue to enlarge or grow.

The chronicity of the tumour is due mainly to three factors, whilst in some cases there is a fourth. In the first place the slow diffusion of the necrosis-producing substance, which probably has its origin in the degenerating or autolysing larva, tends to produce a slow development of the necrosis, and to maintain it for some time. Secondly, the type of necrosis is that which is not readily absorbed or removed. The types of necrosis, or the characteristic changes of necrosis, depend mainly upon the intracellular enzymes. The necrosis-producing substance in this case must lead to an early destruction of the autolytic enzymes of the cells, thus preventing further degenerative changes in the dead cells.[1] Thirdly, because of the lack of chemotactic substances no neutrophile leucocytes enter to remove the dead tissue. Fourthly, there is the possibility of a super-infection. If a tumour has resulted from an infection of a wound, or after ulceration of a tumour has taken place, the possibility of the entry of fresh larvae must be considered. This super-infection has been very distinctly observed in tumours examined from cases occurring in the British Solomon Islands.

There seems to be no doubt that the presence of the larvae in the subepithelial tissues is accidental. The larvae apparently have no power of completing their life-history, for even in the earlier lesions they always show retrogressive changes, while in the older lesions one may be unable to detect anything but a few worm canals, empty or containing a granular *débris*.

However, soon after their introduction the larvae must exhibit some progressive movement, for they penetrate to some depth into the subepithelial tissues, and, in the looser tissues, such as are found in the sheath, they become more dispersed. But this power of penetration is distinctly limited, and the larva is soon unable to maintain its life, probably on account of an inability to obtain a suitable food supply.

The larva cannot correctly be called a parasite, for a parasite may be defined as a living organism which takes up its abode on or within other living organisms for the purpose of obtaining food.

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(1) That absorption of dead tissue depends mainly upon the completeness or incompleteness of the destruction of the intracellular enzymes is illustrated by the following experiment:—Two pieces of fresh normal tissue, one heated to 100° C., and the other untreated, when placed in the abdominal cavity of the same species undergo very different changes. The unheated tissue soon undergoes autolytic changes and is absorbed, whereas the heated tissue, although dead, undergoes no autolytic changes, and is very slowly absorbed.

There seems to be little doubt that the larva present in the lesions belongs to the genus *Habronema*.

In tracing the evolution of these tumours from the earliest recognizable lesion, and taking into consideration their situation in or just beneath the skin or external mucous membranes, it seems reasonable to assume that the larvae are introduced from without and are not carried to the surface from within. A point to be decided is whether larvae of *Habronema* can enter the submucosa of the external mucous membranes or the subcutaneous tissues, and so make their way to the alimentary canal, or not. If the larvae are capable of doing this, as larvae of *Ankylostoma* are, then it is remarkable that they should so often be held up in the submucous or subcutaneous tissues. There is nothing to suggest that this is a common or even probable mode of invasion.

Experimental observations have shown that, although larvae are capable of migrating in the subcutaneous tissues for some little distance from the point of entry, this migration is very limited, and the larvae are soon surrounded by leucocytes. It would appear, therefore, that the presence of the larvae in the submucosa of the conjunctiva, and of the urethra or the subcutaneous tissues, is an accidental phenomenon.

All the larvae found in the tumours have presented the same appearances, and must be regarded as being of the same stage of development. There is nothing to suggest that the larvae have passed through any developmental stages in the tissues of the horse.

As the larvae found in the granulomata are in the same stage of development as those found in the head and proboscis of adult flies, it would appear that flies are in some way responsible for the production of the lesions. This is also suggested by the fact that the granulomata only occur at that time of the year when flies are present in abundance.

Observations on the life-histories of the three species of *Habronema* have shown that *H. muscae* develops through its larval stages in *Musca domestica*, but it is not capable of such development in *Stomoxys calcitrans*, at least under experimental conditions; *H. megastoma* has the same life-history as *H. muscae; H. microstoma* develops through its larval stages in *Stomoxys calcitrans*, and shows, sometimes at least, an aberrant development in *Musca domestica*.

Harvey Johnston (1912) has recorded the finding of a larva somewhat resembling that of *H. muscae* in *Musca vetustissima* in Queensland, so it seems possible that these species may be capable of developing through their larval stages in other flies, particularly Muscids. Nothing, however,

is at present known about the possible development of these species in other flies, and as it would appear that the usual mode of development is as outlined above, the possible association of *Musca domestica* and *Stomoxys calcitrans* with the production of the lesions must be considered.

The affection, as it has been observed by the present writer and by Lewis and Seddon, is most commonly situated in or about mucous membranes, *viz.*, the mucous membrane of the urethra and that of the eye. Lesions are found, nevertheless, in other situations as on the sheath or the limbs.

Why should these lesions be more commonly found in mucous membranes? The first explanation which suggests itself is that *Musca domestica* is attracted to these situations in search of moisture and food. Should larvae escape from the proboscis during feeding operations, there would be sufficient moisture present on the mucous membrane to prevent desiccation. Under these conditions it is possible for the larvae to penetrate the mucous membrane should they desire to and be capable of so doing.

Larvae found in the lesions resemble those of *Habronema muscae* and *H. megastoma*, the cuticle of both these forms possessing longitudinal ridges, but not those of *H. microstoma*, the cuticle of this form showing no longitudinal ridges.

H. megastoma is found in tumours situated in the submucosa of the stomach of the horse. It is generally believed that it perforates the gastric mucous membrane, probably when in the larval stage. In its normal situation the parasite would live on the products of the tissues rather than on the semi-digested material in the alimentary canal. It is, therefore, a parasite of tissues rather than of the contents of the alimentary canal.

From a theoretical consideration one would expect the larva of *H. megastoma* to possess the instinctive desire to penetrate mucous membranes, and, further, to be able to maintain its life in the submucous tissues of the urethra and conjunctiva or the subcutaneous tissues longer than the larvae of the other two species. This suggests that the larva of *H. megastoma* is more likely to produce a habronemic granuloma than the larvae of the other two species. Experimental evidence also suggests that the larva of *H. megastoma* more readily penetrates the conjunctiva of the horse and sets up a granulomatous reaction, and also that it more readily sets up a granulomatous condition in the subcutaneous tissues than the larvae of *H. muscae*.

Although the experimental evidence suggests that the larva of *H. muscae* does not readily penetrate the conjunctiva or produce a granulomatous reaction in the subcutaneous

tissues, it is not possible to say that it is never responsible for the production of a habronemic granuloma.

Clinical and experimental observations suggest that the production of a habronemic granuloma depends in some degree upon the susceptibility of the animal. It seems possible that the presence in the subcutaneous tissues of larvae of any of the three species of *Habronema* may set up a typical granuloma, provided the animal possesses a susceptibility to the particular species present.

Experimentally it has been shown, for example, that the presence of larvae of *H. microstoma* in the subcutaneous tissues may set up a granuloma with typical caseous areas, whereas, in the same animal, the presence of larvae of *H. megastoma* or *H. muscae* may produce nothing more than an acute inflammatory oedema, which quickly disappears, and is followed by no subacute or chronic changes.

It seems possible, further, that certain tissues may react in such a way as to produce a habronemic granuloma, while other tissues in the same animal show no such reaction. The larvae of *H. megastoma*, for example, may set up a habronemic conjunctivitis, but when present in the subcutaneous tissues of the same animal little or no reaction is produced (*vide* experiments).

Assuming that larvae of *H. megastoma* are responsible for the production of habronemic granulomata, it seems possible that certain varieties of the same species are more likely to produce these lesions than other varieties. Certain varieties, for example, may possess more vigour in penetrating mucous membranes or moist surfaces, or they may possess greater powers of adaptation. The same may be true for the larvae of the other two species.

It is possible that habronemic granulomata may be due to the larvae of some unrecorded species of *Habronema*, though it does not seem very probable.

The fact that habronemic granulomata are to be found in situations other than external mucous membranes led to the advancement by the present writer of an hypothesis that *Stomoxys calcitrans* was probably responsible for the inoculation of the larvae into the tissues of the horse. It has now been shown that *S. calcitrans* is the intermediate host of *H. microstoma*, and that in the final larval stage the larvae of this species show no longitudinal ridges in the cuticle. This larva cannot, then, be responsible for the granulomata observed by the present writer in Southern Australia. It is possible that *S. calcitrans* may be the intermediate host of some other species of *Habronema*, the larva of which shows longitudinal ridges in the cuticle; but there is probably no

necessity to fall back on such an hypothesis as this. It seems possible that *S. calcitrans* infested with larvae of *H. microstoma* may inoculate these larvae into the skin of a horse with the production of a granuloma. It has been shown experimentally that larvae of *H. microstoma* are capable of producing a typical granuloma in the subcutaneous tissues. The occurrence of such a granuloma under natural conditions, however, has not been definitely observed in Southern Australia by the present writer, although the lesion taken from the metacarpus may possibly have been due to these larvae.

As far as can be ascertained the granulomata observed on the sheath and limbs have not resulted from infection of a wound. In no case has there been a history of a previous wound. It is possible that small wounds may have been overlooked, but it must be conceded that the sheath is a very uncommon site for wounds.

These granulomata appear about the sheath and limbs, sites commonly attacked by *Stomoxys calcitrans*. When one or more of these flies bite they often produce some swelling in the skin, and an exudation of blood or serum occurs through the puncture wound. It seems possible that *Musca domestica* when coming to feed upon this exudate may contaminate the site with larvae of *Habronema*. The larvae would find sufficient moisture to prevent their desiccation, and would probably be able to make their way through the puncture wounds into the skin and subcutaneous tissues.

Wounds would often present ideal conditions for contamination by larvae and their subsequent penetration into the deeper tissues. It is probable that this method of infection does occur, but there seems to be no doubt that it is not the only method of infection.

Habronemiasis is so common in horses that it is rare to find a stomach free from one or other of the three species. This being so, it is remarkable that habronemic granulomata should be of such infrequent occurrence in Southern Australia and other temperate countries. There are several possible reasons for this:—(1) *H. megastoma* is not as common as the other species. It has been suggested that larvae of *H. megastoma* are probably the commonest cause of habronemic granulomata. In the experience of the present writer *H. megastoma* is the least common of the three species to be found in the stomach of the horse. This fact would tend to lessen the frequency of the occurrence of the granulomata if larvae of *H. megastoma* are the causal organisms. (2) The escape of larvae from the proboscis of flies is not a common occurrence. It would appear that the larvae may escape from

the proboscis of *Musca domestica* when that fly comes to feed on moist surfaces. The escape of the larvae from the proboscis appears to depend upon the rupture of certain structures in the proboscis. This rupture appears to depend directly upon the number of larvae present and their activity. Unless conditions are such as to allow of the development of a large number of larvae in the fly, and the temperature is high enough to produce marked activity in the larvae, then it would appear that the escape of larvae from the proboscis is not very likely to occur. Experimental observations have shown that the escape of larvae from the proboscis is not of frequent occurrence. (3) All animals do not appear to be susceptible. (4) It seems possible that certain strains or varieties of the same species are more likely to produce lesions than others.

In each granuloma examined there have been a large number of larvae or necrotic areas present. This indicates that there is usually a massive infection at one point. Super-infection has not been found to be of common occurrence. Only in one tumour examined was this suggested by the fact that larvae showing marked retrogressive changes were present along with others showing very early retrogressive changes. Massive infection at one point, therefore, does occur, and is probably explained by the fact that the larger the number of larvae present in the proboscis of a fly the more likelihood of rupture of the proboscis and the escape of the larvae.

Tumours on the glans penis have always been found at the urethral orifice. This suggests that flies are attracted to the moisture about the meatus, and that the larvae after escaping from the proboscis make their way through the mucous membrane of the urethra, and not through the modified skin covering the glans penis. This is supported also by the fact that the necrotic foci are found close to or involving the urethral mucosa while they may be relatively a considerable distance from the external surface.

C. Granulomata as found in Northern Australia.

General.—A granulomatous affection of horses, commonly known as "swamp cancer," and described by Lewis (1914) under the name of equine granuloma, is found in the northern or tropical portions of Australia. The condition has been thoroughly described by Lewis, who studied it in the field, and also conducted some experimental work in an attempt to artificially produce the disease.

The present writer was impressed with the great similarity between this condition and the granulomata observed in Southern Australia. On request, specimens of "swamp

cancer" were kindly supplied by Mr. J. F. McEchran and Mr. C. G. Dickinson.

Macroscopic examination.—Macroscopic examination shows the tumours to vary very little from the granulomata already described. The most marked variation is in the very large size these tumours attain in the north of Australia and their great chronicity. A point to be emphasized is that in the early lesions the necrotic areas are small, pale in colour, and soft, while in the older lesions they are larger, darker in colour usually, and harder. It is evident that the growth of the tumour depends upon an enlargement of the necrotic areas and an increased tissue reaction, *i.e.*, the number of necrotic areas does not increase as the tumour grows.

The necrotic areas when separated out from the surrounding tissues are seen to have an irregular, bosselated surface with some marked irregularities or "branchings." These necrotic areas are typical of "swamp cancer" as of the granulomata described above.

Ulceration of the surface is much more extensive in "swamp cancer" than in the granulomata observed in Southern Australia.

Microscopic examination.—The histological picture is essentially that of a granuloma. There is an increased production of fibrous tissue, which varies with the age and size of the lesion. The tumour is extensively invaded with eosinophile leucocytes. There are collections of mononuclear cells, and an epitheloid (endothelial) cell reaction with, at times, the formation of many multinucleated cells. Necrotic areas occur throughout the tumour, and in the older lesions they are more or less encapsulated. When ulceration of the surface is extensive, neutrophile leucocytes are attracted to the part.

This histological picture is almost identical with that described in the present communication for habronemic granulomata occurring in Southern Australia. The only variation is due to the earlier and more extensive ulceration and secondary infection of the superficial parts of the tumour. This gives rise to an infiltration of the tissues with neutrophile leucocytes, which are found mainly in the more superficial parts of the lesion, but are not seen attacking the caseous areas. The tissue reaction is very marked, being greater the larger the tumour.

The caseous areas have the same microscopic appearance as those already described, but calcification has not been observed in "swamp cancer."

No very early lesion has been examined, so that it has not been possible to demonstrate any larval Nematode. In some cases spaces resembling worm canals have been observed.

Possibly, however, these are blood vascular spaces that have been included in the necrotic area.

The smallest lesion examined was one with a diameter approximately 2 cm. and a depth of about 6 mm. It was raised and had an ulcerated surface. Microscopically there was an extensive invasion of the tissues by eosinophile and neutrophile leucocytes, which were more crowded together in some areas, towards the centre of which typical necrosis had occurred. There were only very few necrotic areas present. The tissues were oedematous and haemorrhagic. The epidermis was in parts oedematous, and invaded by leucocytes. This change had led to ulceration with the formation of a vascular granulation tissue. Towards the edge of the lesion the epidermis showed considerable hypertrophic changes, the epithelium dipping deeply into the subcutaneous tissues, and showing numerous small processes. This hypertrophic change in the epithelium indicates an irritation of some standing. The necrotic areas were sometimes ill-defined and diffuse, and there was no attempt at encapsulation. Multinucleated cells were seen in several parts of the section.

The whole lesion was examined in serial section and no larvae were discovered. The lesion, although a very small one, was probably of several weeks' standing, and not as early as might be assumed from its size. A consideration of the hypertrophic changes in the epithelium, which must have been of several weeks' duration, led to this conclusion.

It may be mentioned here that there is a granulomatous condition affecting horses in the Solomon Islands known under the name of "swamp cancer." This condition is discussed elsewhere, and must not be confused with the "swamp cancer" of Northern Australia.

Discussion.

There is a great similarity between the macroscopic and microscopic pathology of "swamp cancer" and habronemic granuloma as observed in Southern Australia.

The condition is undoubtedly a granuloma, and is due to a reaction on the part of the tissues to an invasion by some organism. It belongs to that type of reaction most commonly seen in animal tissues that have become invaded by some larval or adult verminous parasite. The reaction is so similar to that seen in some habronemic granulomata as to suggest that the condition is due to a similar cause. No larvae have been found in the tissues, but this is not proof that they have not been there at some time, and that the tumour is not the result of the invasion. At the same time there is no proof that larvae are responsible for the reaction.

Attention has already been drawn to the fact that the tissue reaction and necrosis found in habronemic granulomata are essentially the same as those found quite commonly in the internal organs of herbiverous animals following the death in the tissues of migrating parasites. Experience leads one to believe that a granuloma containing necrotic foci, showing a marked eosinophilic invasion and the formation of multi-nucleated cells, is due to the reaction of the tissues against an invasion by a larval or adult metazoan parasite, usually a Nematode. There seems to be no reason to suggest that "swamp cancer" offers an exception.

It is now known that these lesions in the skin and external mucous membranes of the horse are most commonly due to a larval *Habronema*, and there is strong presumptive evidence that "swamp cancer" is due to a similar larva.

It has already been shown that in older lesions larval *Habronema* cannot be demonstrated. It is difficult in a country like the Northern Territory of Australia to obtain early lesions, for the animals are not under constant supervision. Lesions that have been sent to the present writer and described as early lesions have been found on examination to be small lesions, but of some standing. It seems almost certain that many of these small lesions would never develop into the large, chronic lesions. Their small size appears to depend upon the few necrotic areas present and a resistance on the part of the animal which is apparently absent in those animals which develop large, chronic lesions.

Experimentally it has been shown that larvae belonging to all three species of *Habronema* are capable of penetrating the tissues for some distance from the point of entry. At least two of these can set up a chronic irritation which leads to the formation of a granuloma containing necrotic foci. Experimentally it has also been shown that apparently the tissues of some animals offer a strong resistance to the presence of these larvae, and are capable of quickly destroying them before they are able to produce much reaction. It will be seen, therefore, that the possibility is that "swamp cancer" may be due to any one of the three species of *Habronema*. Evidence is not in favour, however, of the probability of "swamp cancer" being due to larvae of either *H. muscae* or *H. megastoma*. These two forms pass through their larval stages in *Musca domestica*, and as this fly is not usually to be found far afield, it seems probable that it is in no way associated with the occurrence of "swamp cancer." It seems more probable that *H. microstoma* may be the species responsible for the lesion. As this species passes through its larval stage in *Stomoxys calcitrans* there is more chance of horses in the field becoming inoculated with these

larvae than with those of the other two species. It has been shown experimentally that larvae of *H. microstoma*, although being able to set up a typical reaction with necrosis, quickly disappear in the tissues. If "swamp cancer" be due to the larval form of *H. microstoma*, it seems possible that this is one of the reasons for the failure so far to demonstrate the presence of any larvae in the tissues. Also, as the presence in the skin of larvae of *H. microstoma* would apparently depend upon their inoculation by *Stomoxys calcitrans*, a super-infection would at least be uncommon; therefore, one would not expect to find larvae only a few days old in an ulcerated lesion, as is possible in those due to the larvae of other species of *Habronema*. If "swamp cancer" is due to the final larval stage of *H. microstoma* as seen in *Stomoxys calcitrans*, then the probability of its demonstration in the lesions would appear to be somewhat remote.

It seems possible also that "swamp cancer" may be due to other species of *Habronema* carried by some other form of muscid such as *Musca vetustissima*, which may be found further afield than *Musca domestica*. If *M. vetustissima* were responsible one would expect to find lesions in the conjunctiva. As far as one is aware these have not been observed, nor have the lesions been observed on other external mucous membranes. Lesions have, however, been observed on the sheath and limbs, sites commonly attacked by *Stomoxys calcitrans*, so that the suggestion that this fly may be responsible seems more likely to be true than the latter suggestion.

The observations and experiments made by Lewis are of importance. He has shown that "swamp cancer" occurs on those parts of the body commonly attacked by *Stomoxys calcitrans*. He has discussed the possibility of "swamp cancer" being due to a verminous infection, but has come to the conclusion that it is improbable. He believes that the eosinophilia observed in the lesions is due to the reaction of the breaking-down epithelium, and calls the reaction a local eosinophilia.

General eosinophilia may or may not be demonstrable, but in any case the eosinophile leucocytes found in the lesion have to be brought there by the circulating blood. Lewis is not very clear on the distinction he wishes to draw between a general and a local eosinophilia. Apparently he claims never to have found eosinophile leucocytes in the vicinity of verminous parasites. This is contrary to the experience of the present writer. It may be granted, however, that the presence of eosinophile leucocytes in a tissue is not always indicative of the presence of a verminous parasite.

Lewis is also of the opinion that the evidence is strongly opposed to the possibility of flies acting as the carrier of the infection. This conclusion is based on the fact that the number of biting flies in the Territory is considerable, but he has observed no preference on the part of the flies as to the portion of the horse to be attacked, whereas "swamp cancer" lesions occur mainly about the legs and abdomen. He states, however, that the biting flies present are chiefly Tabanidae, and it is on observation of the presence and habits of these flies that he draws his conclusions.

Lewis concludes that the probability is that the virus which causes the lesions "is normally a habitant of the swamps." There seems to be some evidence to suggest that in swampy districts horses are more prone to the affection. This may possibly be explained, however, by the fact that in such areas horse dung is liable to remain longer in a moist state and be more attractive as a breeding ground for *Stomoxys calcitrans*. He has demonstrated that the condition is not contagious. His attempts to obtain micro-organisms by cultural methods failed, and all attempts to reproduce the lesions artificially by inoculation of portions of tumours from horse to horse gave negative results. These results are important, and are not incompatible with the hypothesis that the lesions are due to some verminous infection.

Lewis himself admits that "the inability to reproduce the disease artificially from horse to horse suggests one of two things—either the presence of an intermediate host or carrier is necessary, or the appearance of the causative agent in the horse is an accidental phenomenon. . . ." These conclusions actively support the above hypothesis, for if the lesions are due to a larval *Habronema*, the presence of an intermediate host or carrier is necessary, and, moreover, the appearance of the causative agent in the horse is, as far as we know, an accidental phenomenon.

"Swamp cancer" occurs in horses in the field, but when these animals are brought in and placed on "hard food," Lewis informs us, the tumours gradually disappear. If the granulomata are due to a larval *Habronema*, this result is not very surprising, for in this case there is present no virus or micro-organism capable of multiplication in the tissues and of causing a progressive infection. If "swamp cancer" is due to a mould parasite, or some virus that is capable of multiplication in the tissues, this result is remarkable. If this be the case, it is also remarkable that necrotic areas do not increase in number and occur in all stages of development. Further, the failure of Lewis to transmit the disease from horse to horse can be taken as very strong evidence against the probability

of the condition being due to some micro-organism or virus capable of multiplication in the tissues.

"Swamp cancer" certainly shows a variation in non-essential characteristics from habronemic granulomata as seen in Southern Australia, but this is possibly due to several factors. In the first place, it is unlikely that "swamp cancer" is due to an invasion of larvae of either *H. muscae* or *H. megastoma*. In the second place, horses running in the field, where the natural grasses are not always very nutritious; are likely to react differently from those kept on a highly nutritious diet ("hard food"). In the third place, the climatic conditions would have a decided effect on the nature of the reaction to an invasion by a larval *Habronema*.

In a previous publication the opinion was expressed that "swamp cancer" is almost certainly a variation of the affection observed in Southern Australia. After a more extensive experience in the examination of specimens, and after certain experimental studies, this opinion is still held.

In conclusion, it may be said that there is strong presumptive evidence to suggest that "swamp cancer" as observed in the northern parts of Australia is due to the invasion of the tissues by a larval *Habronema*, and that the species responsible is possibly *H. microstoma*, in which case it would most probably be introduced into the tissues by *Stomoxys calcitrans*.

D. Similar Granulomata as found Outside Australia.

1. *"Summer Sores."*

This affection was first described, in 1850, by Bouley. Rivolta, in 1868, isolated a worm from the sores, and called it *Dermofilaria irritans*. Laulanié confirmed this discovery in 1884. Since that time many observations on "summer sores" have been published. The literature bearing on the subject has been reviewed by Railliet (1915).

The affection has been variously named "summer sores," "granular dermatitis," "estival sores," "granular sores," and "esponja."

A typical lesion shows a granulomatous sore possessing small caseous nodules varying in size from that of a grain of millet to that of a pea. The lesions show variations in character according to the country in which they occur, climate and other conditions, but the presence of the caseous nodules is characteristic. Resistance to treatment, chronicity, and an accompanying pruritus are also characteristic features of the affection. The parts most commonly affected are the extremities, but the head and chest, and also the conjunctiva, are frequently the sites of lesions.

The condition has been described as occurring mainly in India, Africa, and tropical America.

For the most part the descriptions both of the pathology and the associated larvae have been neither very accurate nor full.

Railliet in his report deals extensively with the researches of Descazeaux, who studied the condition in Brazil. Descazeaux conducted some careful observations, and his contribution has considerably advanced our knowledge of the affection.

The following is a brief summary of the description as given by Descazeaux:—

"Summer sores" appear during the summer; during the winter these tumours disappear totally or in part, to reappear on the first return of heat. Three to 4 per cent. of horses and mules were found affected. The parts of the body most affected are the external surfaces of the extremities, the canon, the knee, and the lateral and superior parts of the neck. The condition is found in two stages. In the first stage the tumour is only inflammatory. Old lesions will again become active. The tumours are circular, non-adherent, and 1 to 1·5 cm. in thickness. In the second stage (15 to 20 days) the circular tumour varies in extent up to 30 cm. in diameter and 2 to 5 cm. in thickness; it is very fibrous and adherent to subjacent tissues, the superior part of the tumour being ulcerated. The tumour presents a tendency to enlarge. The surrounding skin is thickened, indurated, and elevated by a number of nodules, which soon ulcerate and become confluent. The ulcerated surface becomes covered by granulations. Pruritus is intense. The sores last six to nine months, and resist all treatment. Cold acts favourably upon them, and in the first months of the winter, if they are not very extensive, they may completely heal. If the sore is only in the first stage it will disappear in from four to six days.

Pathological Anatomy.—At first the "Esponja" has the characteristics of an inflammatory tumour; it is very vascular and easily excised. Later the tumour becomes hard, fibrous, and infiltrated with calcareous "grains." On the cut surface these "grains" are seen to vary in size from that of a pin's head to that of a pea, and they enucleate very easily.

Microscopical.—The tumour in the first stage shows roughly three layers or areas—a deep layer formed by loose fibrous tissue and vascular spaces; a middle layer with little fibrous tissue but a considerable infiltration of leucocytes and eosinophiles; a superior layer formed chiefly of thickened fibrous tissue. In the middle, parasitic caseous areas are seen. These are oblong or round, measuring from 800 μ to 900 μ in length by 300 μ to 400 μ in breadth.

The worms are found in these necrotic areas, and vary from two to five in number. Some areas present a central cavity which was primarily occupied by the parasite. In tumours of the second stage it is difficult to find typical parasitic "tubercles." The tumours consist mainly of dense fibrous tissue. Sometimes the *débris* of a parasite is seen.

Descazeaux also gives a description of the "parasite" which as Railliet has shown, he wrongly considered to be a mature female. This parasite he calls the "constant parasite,"

and describes it as being from 2·4 to 2·8 mm. long by 45 to 50 μ broad, body filiform, terminating posteriorly in a blunt point furnished with bristles; cuticle striated longitudinally. In one sore he found, on dissecting the superficial part, five examples of a larva which he calls the "inconstant parasite." This is described as being 900 μ long by 25 μ broad, cuticle smooth, anus at the base of the tail, and vulva at the posterior third of the body.

Railliet draws attention to the occurrence of cutaneous lesions in which larvae have been found, but which differ from the "constant parasite" of Descazeaux. He recalls that Ercolani met with embryos of a Nematode in a horse on which were found "umbilicated crusts" about 1 cm. broad and very adherent. The crusts implicated the entire thickness of the skin, and were localized at the lower surface of the body along the *linea alba*, where there were also many bare patches. In these crusts Ercolani found a small Nematode, which was characterized by keeping its caudal extremity doubled under the body and making frequent movements of abduction. He called the worm *Trichina uncinata*. Unfortunately no dimensions were given. Railliet remarks that Haubner described this condition under the name of "placoregma," and that the affection, which has also been described by Cadeac, presents a very marked resemblance to "summer sores."

Railliet mentions that Buffard found embryos in oedematous plaques which somewhat resembled the lesions of dourine. These embryos measured 80 to 90 μ long by 3·5 to 4 μ broad. Buffard believed these to be the embryos of *Filaria papillosa (Setaria equina)*, but Railliet shows that he was mistaken.

Railliet believes that the embryos found by Ercolani and Buffard are embryos of *Habronema*.

Further, Railliet believes that the "inconstant parasite" of Descazeaux is an early larval stage of *Habronema*, resembling stage 2 of *H. muscae*, as described by Ransom.

Fayet and Moreau described a larva measuring 2·5 to 3·5 mm. long by 50 to 90 μ broad, which possessed longitudinal striations, but spines on the caudal extremity were not mentioned. Railliet believes that if the larva really lacked the covering spines at the tip of the tail it would fall into one of the stages between 3 and 5 of *H. muscae*, as described by Ransom.

The main part of Railliet's paper deals with the classification of the larval Nematode found in "summer sores." The fact that the larva possesses a spinous tip at the end of the tail has enabled Railliet to definitely place it in the superfamily Spiruroidea. The larva corresponds closely to the sixth

larval stage of *Habronema muscae*, as observed by Ransom in *Musca domestica.*

After discussing the findings of the various authors, Railliet comes to the conclusion that the Nematode of "summer sores" is none other than a larva of Spiroptera of the genus *Habronema*. His general conclusions are as follows:—

1. The parasite of verminous dermatitis is an embryo or a larva of *Habronema*, which it is rational to ascribe to one of the three species of the genus living in the stomach of the horse.
2. The clinical forms of the affection vary in a certain measure with the stage of evolution of the parasite and with the climate.
3. It is probable that the infection of the horse occurs from without inwards by contact with manure, which harbours the embryos of *Habronema* rejected with the excrements, and that these embryos evolve in the skin as they do normally in the body of the fly.
4. It is possible also that the larvae escape from the proboscis of the fly in contact with the sores.

More recently van Saceghem (1917) published a summary of some observations he had made on "granular dermatitis" as it occurs in equines at Zambi, Lower Congo. He found that the condition occurs only in animals kept in stables. The bedding was changed and the dung removed regularly from these stables.

The disease is never localized in the hindquarters, but always in the fore quarters, on the legs, and the inner canthus of the eye. Lesions in other situations are rare. Equines which are allowed to live at liberty never present the disease. In a stable where several horses were affected with "summer sores" he found that 20 per cent. of *Musca domestica* were infested with a Nematode larva 2·5 mm. long by 65 μ broad. The larva possessed an elongated, pointed, anterior extremity, and a blunt posterior end studded with bristles. The larvae showed no longitudinal striations.

The larvae found in the sores were 50 μ broad, and showed marked longitudinal striations. The lesions usually show a large number of calcified larvae and a few living ones. He says that there is thus a massive infection at a single point, and it is not very probable that these larvae are all conveyed during one short period of time to the same point.

In a later communication, van Saceghem (1918) records the results of some experiments, and concludes that flies are the vectors of the *Habronema* larvae, and that the larva found

in the verminous nodules is an aberrant larva of *H. muscae*.

In his earlier communication he says that in a few *post-mortem* examinations made at Zambi no specimens of *H. megastoma* were found. His conclusion was that *H. megastoma* was either absent or very rare at Zambi. In his experiment he, therefore, deposited larvae of *Musca domestica* on a freshly voided mass of dung from a horse "known to be infected with *H. muscae*." When the adult flies hatched out they were found to be infected with larvae in a proportion of 70 per cent. Larvae isolated from some of these flies and transferred on to the hair or shaved skin of a horse were found to die off rapidly and show no tendency to pierce the skin. When deposited on wounded surfaces covered with serous fluid they executed movements, and showed a marked tendency to become lodged in small crevices. He also deposited larvae in the inner canthus of the right eye of a horse which was kept isolated within an enclosure surrounded by fine mosquito netting. The animal subsequently became affected with conjunctivitis, and verminous nodules developed on the *membrana nictitans*. The left eye, which served as a control, showed no change.

A further experiment was conducted in which two wounds were made in the skin of a horse; one wound was protected against flies and the other was left uncovered. The animal was placed in a stable in which 20 per cent. of the flies were infested with *Habronema* larvae. The unprotected wound became the seat of intense irritation, which caused the horse to bite itself. The wound became transformed into a characteristic "summer sore."

Discussion.

There can be no doubt that the etiology of the tumours found in Southern Australia and of those found elsewhere, and usually called "summer sores," is the same. The larvae found in "summer sores" appear to be identical with those found in Southern Australia. Fayet and Moreau, Descazeaux and van Saceghem have all described the presence of longitudinal ridges in the cuticle, which also characterizes the larvae found here. Unfortunately the descriptions of the larvae have been very inaccurate, and in many cases they have been regarded as adult forms. It was not until recently that the etiology of the condition was established by Railliet in his interpretation of the work of Descazeaux.

Although there are certain variations in the characters of the lesions, for the most part they are fairly constant. Those lesions in which embryos have been found do not appear to resemble a typical "summer sore" very closely. Railliet

believes that the clinical form of the malady may be in agreement with the stage of evolution of the parasite.

There appears to be very little evidence to support Railliet's theory, *viz.*, that the lesions are due to the penetration of the skin by embryos which develop as erratic parasites in an abnormal situation in undergoing an analagous development to that which they accomplish normally in the body of the fly. It has been shown experimentally that the final larval stage can produce a typical reaction, so, at least, this aberrant development does not appear to be necessary.

It is possible that embryos may either penetrate the skin or become lodged in sores, where they may set up a tissue reaction, but there is no experimental evidence to support this assumption.

Even if we assume the possibility of embryos of *Habronema* setting up a certain type of lesion in the skin, there appears to be little or no evidence to suggest that such embryos are capable of developing through their larval stages in this situation. Further, there is no proof that the embryos found by Ercolani in the one case, and by Buffard in the other, are embryos of *Habronema*.

Embryos of *Habronema* are to be found in the faeces at all times of the year. If these embryos leave the faeces, and in penetrating the skin and their subsequent evolution they set up a typical "summer sore," it is difficult to explain (1) the seasonal occurrence of the tumours and (2) the massive infection at one point.

The life-history of the three species of *Habronema* is of that type which involves a simple alternation between two hosts—one a vertebrate harbouring the adult and the other an invertebrate harbouring the larval stage. From a theoretical consideration it seems reasonable to assume that it is improbable, should this alternation be broken, that the worm would be able to carry on its development.

Before Railliet's theory can be accepted it will require the support of more clinical and experimental evidence.

The "inconstant parasite" of Descazeaux, believed by Railliet to be an early larval form of *Habronema* resembling stage 2 of *H. muscae* as described by Ransom, is not definitely a larval *Habronema*. It was described by Descazeaux as a "larve strongyloide." He described the anus as being open and situated at the base of the tail and a vulva situated at the posterior third of the body. The larva is 900 to 950 μ long by 25 μ broad. It will be seen that the larva is approximately only half the width of a *Habronema* larva. From an early stage resembling that of stage 1 of Ransom the growth of *Habronema* larvae is mainly in length, the width or

diameter remaining approximately constant throughout. The presence of an open anus at the base of the tail is against its being a *Habronema* larva. A larval *Habronema* has a closed anus with a very prominent anal operculum in the early stages, and only in the final larval stage is the anus open. It seems possible that the form may be an aberrant larva of *H. microstoma*, as is sometimes seen in *Musca domestica*. It is also possible that the larva does not belong to the genus *Habronema*. Railliet has taken the presence of this larva in one sore examined by Descazeaux as evidence in favour of his theory that embryos of *Habronema* are capable of developing through their larval stages in the skin of the horse. If the form is a larval *Habronema* it is certainly aberrant, but there is no proof that it has developed from an embryo in the skin of the horse. There is no proof, moreover, that the form is a larval *Habronema*. It is doubtful, then, that this finding really can be taken as supporting Railliet's theory.

Further, there is little support for Railliet's theory to be found in the fact that Fayet and Moreau did not describe the presence of a spinous tip to the tail of the larva they found. In all other respects their larva resembles that usually found in "summer sores," and it is probable that they failed in common with others to detect the spinous tip.

The fact that larvae at an earlier stage than the final are sometimes present in the proboscis of a fly must not be overlooked. Should these earlier larvae be present in the proboscis along with larvae in the final stage, and should the larvae escape from the proboscis, it is possible that these earlier larval stages may be present in a lesion along with the later stages. Therefore, the finding of larvae of an earlier stage could not be taken as proof of development of the larvae in the tissues of the horse.

Van Saceghem's observations and experiments strongly suggest that flies play an important *rôle* in the production of the lesions. His experiments have shown that the larvae of *Habronema* when placed in the inner canthus of the eye are capable of setting up a typical habronemic conjunctivitis. He showed, further, that an open wound may develop into a typical "summer sore" if the animal is placed in an environment where flies are heavily infested with larvae. This is strong presumptive evidence in support of his conclusion that the larvae in the wound escaped from the proboscis of the fly when the latter came to feed upon the raw surface.

Larvae found by him in "summer sores" were 50 μ in diameter, and showed marked longitudinal striations in the cuticle, whereas those found in flies caught in a stable were 65 μ in diameter and showed no longitudinal striations. He

does not mention what means were taken to determine the presence or absence of longitudinal striations. In sections of a lesion a transverse section of the larva would clearly reveal the presence of the longitudinal striations in the cuticle. Unless transverse sections were made of the larvae isolated from the flies longitudinal striations could not have been demonstrated. If all means were taken to determine the presence or absence of these striations then, one may assert with confidence, that the larvae isolated from the flies by van Saceghem were neither larvae of *H. muscae* nor *H. megastoma*, but the larvae of some other species probably not yet described, although there is a possibility that they may have been the larvae of *H. microstoma*.

There is no proof that the larvae used by van Saceghem in his experiments were the larvae of *H. muscae*, as he claims. His experiments are valuable in demonstrating that the final larval stage of *Habronema* is capable of producing a typical lesion, but they do not help in the specific determination of the larva responsible.

It is interesting to note that Descazeaux records the fact that a typical "summer sore" may develop without any pre-existing wound or sore in the skin ("dans certains cas on observe des tumeurs parasitaires sans qu'il soit possible de déceler la moindre lésion cutanée"). Railliet mentions that Lingard in studying "bursati" in India observed the presence of the characteristic *kunkur* in some cases before the formation of any ulcer. Van Saceghem observed that on parts of the body where "summer sores" were subsequently set up an intense pruritus was manifested before the appearance of the visible lesion ("J'ai pu observer très souvent qu'au niveau des régions où va se déclarer une plaie d'été, avant l'apparition des lésions visibles, l'animal souffre d'un prurit intense qu'il manifeste en se mordant jusqu'au sang").

It is possible that these observations may show that a "summer sore" does not always result from the infection of an ordinary wound. The conclusions already reached with regard to the probable mode of infection are, therefore, not inconsistent with the facts as gathered from other parts of the world. It seems probable that the larvae responsible for the production of a "summer sore" are either that of *Habronema megastoma* or *H. muscae*, although there is a possibility that some unrecorded species may also be responsible.

2. "*Swamp cancer*" *in the Solomon Islands.*

Through the courtesy of Mr. John Scott, the present writer has had an opportunity of examining specimens of a

granuloma that is commonly found affecting horses in the Solomon Islands.

The following information has also been kindly supplied:—About 75 per cent. of horses in the Solomon Islands suffer from a form of "swamp cancer," which attacks the pasterns only. The tumours vary in shape and size from those showing a flat, raised surface with a diameter of about 1 inch to those showing a rounded surface and a size somewhat larger than a cricket ball. The lesions do not appear to cause the animals any pain. They are very chronic and may last for years. They do not appear to occur at one time of the year more than another. The animals, for the most part, are grass fed, worked through the day and turned out in the horse-paddock at night. Horses running at pasture appear to be affected in about the same proportion as those at work. The horses are mostly used for saddle work. The district is comparatively dry, but is subject to very heavy dews. The area is threaded with tidal lagoons, usually closed at the mouth. Horses having no access to swamps or waterholes are commonly affected. The animals are never more distant than a mile from habitations.

The macroscopic appearance of the tumours is very similar to that of habronemic granulomata. The surface is usually ulcerated. The tumour is very dense and tough, and on section is seen to contain numerous yellowish, caseo-calcareous nodules, not usually larger than a millet seed. These necrotic areas are more numerous than seen in tumours occurring in Australia. A vertical section of one tumour, with an area of approximately 10 sq. cm., contained approximately 140 necrotic areas, some more or less sclerosed.

The microscopic picture is very similar to that described as found in habronemic granulomata in Australia. The differences are due to the more chronic nature of these tumours. The fibrous tissue is dense and sclerosed. The tissues are infiltrated with eosinophile leucocytes. Many of the necrotic areas have been absorbed and their place taken by fibrous tissue. This process is seen in various stages. There is a marked tendency for the occurrence of a deposit of calcareous material in the necrotic areas. Larvae showing a cuticle with fine longitudinal ridges are seen in various stages of degeneration.

It is apparent that the larvae present are not all of the same age. Many appear to be well preserved and of recent advent, while others have completely disappeared, leaving only the worm canals in the necrotic areas. The necrotic areas are also in various stages of absorption. It appears, therefore, that

the chronicity of the tumour depends upon a repeated invasion of the tissue by larvae.

Portions of larvae have been obtained from lesions, and in the better preserved specimens the characteristic spinous tip at the caudal extremity has been observed. It appears, therefore, that the tumour is a habronemic granuloma.

Discussion.

It is remarkable that such a large percentage of horses becomes affected. As far as is known to the present writer there is no previous record of animals becoming affected to anything approaching the extent of 75 per cent.

Another point of interest is the fact that lesions occur in animals that are not at any time confined to the stable. This is contrary to the usual experience. The animals, however, are not at any time far distant from habitations, so that one would expect to find *Musca domestica* in numbers in their surroundings.

The fact that the tumours occur only in the one situation is of extreme interest. It is not possible, at present, to determine the exact reason for this. It is possible, however, that the animals may be subject to injuries about the pastern, probably due to some rough, cutting grass. It is remarkable, nevertheless, that wounds in other parts of the body do not develop into habronemic granulomata.

The occurrence of lesions in one situation only does not suggest that biting flies are in any way responsible.

The larvae bear the same characteristics as those found in Australia and elsewhere.

3. *"Leeches" and "Bursattee."*

"Leeches."—In North America there exists a granulomatous affection of equines commonly known as "leeches."

According to many writers the lesions are to be found on the limbs and those parts of the body which are liable to come in contact with water when animals are standing in swamps. The disease has been little investigated, and a considerable confusion has existed as to the pathology of the condition, with the result that it has been described as cancer, and numerous other pathological conditions have been included under this name.

There seems to be no doubt that the older writers were wrong in classifying this condition as a malignant neoplasm. It is now generally recognized that the condition is a granuloma, though so little is known of its pathology that many lesions of different etiology are probably still classified

under this popular name "leeches." Hutyra and Marek (1913) classify the condition as a malignant hyphomycosis, although the evidence upon which the classification rests seems to be of rather an insecure nature. No conclusive evidence has been produced demonstrating the condition to be a mycosis.

Fish (1897) came to the conclusion that the condition was due to a fungus. His report deals with a histological investigation of two cases, and a historical account of a supposed similar disease (Bursattee) occurring in India.

He describes a granuloma containing characteristic hard caseous areas with an irregular or bosselated surface. He describes the nodules or caseous areas as being generally irregularly cone-shaped and variable in size, revealing on section a very dense structure the framework of which forms a close reticulum. Within the meshes of the reticulum are what appear to be leucocytes in various stages of disintegration, and free nuclei. He says that it would appear, therefore, as if the framework of the nodule were composed of a mycelial net, which in the course of development has become more or less calcified. He describes and figures the mycelium. The tissue surrounding the nodule shows the presence of numerous leucocytes. These he speaks of as being "spore-laden," but his figures are more helpful than his interpretations, and leave no doubt that he is describing nothing but an eosinophile leucocyte. He also mentions the finding of giant cells in many of the sections.

The interpretations of Fish cannot be accepted without considerable reservation. From his figures one has no difficulty in recognizing his "spore-laden leucocyte" as an eosinophile leucocyte, and likewise his "mycelial threads" appear to be nothing but strands of fibrous tissue in varying stages of degeneration.

The granuloma Fish describes is similar in all essential characteristics to "swamp cancer" and the more chronic granuloma observed in Southern Australia.

Lewis has already agreed that "leeches" and "swamp cancer" are probably the same disease.

It seems reasonable to conclude, therefore, that under the term "leeches" is described a granuloma closely resembling "swamp cancer" in its macroscopic and microscopic appearances, and that it is probably a habronemic granuloma.

"Bursattee".—"Bursattee," or "Bursati," is the name applied to a granulomatous condition affecting horses in India. This condition is classified by Hutyra and Marek as a hyphomycosis and described along with "leeches."

The morbid symptoms are said to consist in the appearance of very firm nodules under the skin of the lips, the nasal alae,

neck, the body and limbs, and, finally, also in the nasal cavities. The characteristic areas, or *Kunkur*, are present in the granulation tissue.

It is extremely difficult to discuss the condition, for most of the descriptions were given in the early or middle part of the nineteenth century, when any knowledge of pathology was not general.

De Haan and Hoogkamer (1903) have described a similar disease occurring in the Sunda Islands. This article is referred to by Hutyra and Marek. Unfortunately the present writer has had no opportunity of consulting the original article.

These authors have claimed that the condition is due to a fungus, but appear to have produced no experimental evidence in support of their conclusions.

Several of the older writers have described lesions as occurring on the mucous membrane of the mouth, but it would appear that they are describing lesions of different character from those occurring on the external surfaces of the body. Also, lesions are described as occurring in the internal organs. Since caseo-calcareous masses are not uncommon in the internal organs of all herbiverous animals, there seems to be no justification in the conclusion of many writers that these masses are "internal lesions" of "Bursattee."

One is forced to the conclusion that under the name of "Bursattee" lesions due to may causes have been described. Nevertheless, there appears to be no doubt that the majority of the lesions described as occurring on the external surface of the body possess characteristics closely resembling those of habronemic granulomata as seen mainly in tropical regions.

Hayes (1906) mentions some very interesting points in connection with the occurrence of the disease. He says, "Although bursattee was very prevalent in Indian stables, say, thirty years ago, it is now comparatively rare; owing, apparently to improved sanitary arrangements, of which the supply of purer water has been the most important factor in the prevention of this disease. It is practically unknown among horses whose stable management, feeding, and watering are properly attended to." This statement is one of some importance, for the association of dirty stables with the appearance of habronemic granulomata is now well recognized. A further observation by Hayes also supports this interpretation. He says, "Horses that have had this disease and remain in the condition under which they have contracted it, are almost certain to suffer from its recurrence. . . ." This is also the case in the occurrence of habronemic granulomata, and is explained by the fact that the animal carries the potential cause of the disease, *viz.*, adult forms of *Habronema.*

Hayes says that the fetlock joints (especially), yard, sheath, front of chest, face, lips, and tongue are the usual points of attack.

In this connection it is interesting to note that the penis and sheath are commonly affected, as is found to be the case in Southern Australia.

Argyle (1910) described the occurrence of bursattee lesions on the corners of the mouth, sheath, and in two cases on the penis at the urethral orifice. In the same year (1910) Hodgkins described a case of bursattee showing lesions on the sheath, breast, fetlocks, internal canthus of both eyes, and the urethral orifice.

Holmes (1915) has come to the conclusion that the disease is probably a mycosis somewhat resembling sporothrichosis of the horse and mule described by Carougeau in Madagascar.

He admits that he is unaware of recorded cases of transmission of the sore from horse to horse. He says that there is not sufficient evidence to prove that Nematode embryos are present in bursati lesions, or that bursati sores or tumours are caused by such embryos.

There may be no evidence to prove that Nematode embryos or larvae are present in the lesions, but this negative evidence is not proof that the lesions are not due to the presence of larvae at some time. It has already been shown that it may be impossible to demonstrate larvae in habronemic granulomata of more than three or four weeks' standing, providing there is no reinfection. In the majority of the lesions collected from animals in Southern Australia examined by the present writer, no larvae have been found. In many of them it has been difficult to demonstrate even any worm canals, but in a series of tumours from early to late one can trace the gradual disappearance of the larvae. Therefore, one is not justified in claiming that a granuloma possessing the macroscopic and microscopic appearances of a chronic habronemic granuloma is not due to a larval *Habronema*, simply because the larva cannot be demonstrated. Experimental evidence suggests that the larvae of *Habronema microstoma*, although setting up a typical granuloma, disappear very rapidly. It seems possible that many of the granulomata in which no larvae can be found may be due to larvae of *H. microstoma*. The bursattee lesions described by Argyle and by Hodgkins, however, appear to be very similar to the habronemic granulomata, as seen in Southern Australia, and to "summer sores." The lesions were found on the mucous membranes of the eye and penis, respectively. This suggests that they, at least, would not be due to larvae of *H. microstoma*, but to the same species as the larvae

responsible for "summer sores" and the lesions found in Southern Australia.

A review of the literature bearing upon these two diseases reveals the fact that these granulomata possess characteristics that are common to habronemic granulomata. They possess such a striking resemblance to habronemic granulomata that it is probable they possess a similar etiology.

E. Nomenclature.

These granulomata have been known for many years under various local names. The cause of the affection having been determined, it became necessary to introduce a more specific designation. Railliet introduced the term *cutaneous habronemiasis.* He says, "Le parasite de la dermatite granuleuse vermineuse est un embryon ou une larve d'*Habronema,* qu'il est rationnel de rapporter à l'une des trois espèces de ce genre vivant dans l'estomac du cheval. L'affection mérite donc d'être désignée sous le nom *d'habronémose cutanée.*"

The disease Habronemiasia is an infection of the stomach of the horse by one or all three species of the genus *Habronema.* The infection consists of the development of larvae into adults which become associated with the mucous lining of the stomach or with the submucosa, and this term would include any other phenonema incidental to the infection. By analogy, the term cutaneous habronemiasis should mean the development of larvae into adults in the cutaneous or subcutaneous tissues where a true parasitism would develop. An infection of this nature does not appear to occur, and certainly it does not occur in the granulomatous conditions that have been discussed. If Railliet's theory that the embryos of *Habronema* develop through larval stages in the cutaneous tissues be proved, it is doubtful even then that the designation cutaneous habronemiasis would be correct.

Ankyostomiasis is the disease caused by species of the genus *Ankylostoma.* The disease is a toxaemia resulting in a progressive anaemia, and is due to an infection of the intestine by the worm. When the larvae of these worms enter the skin they may give rise to a dermatitis. It would not appear to be correct to name this dermatitis cutaneous ankylostomiasis.

Following the same lines of reasoning it does not appear to be correct to give the designation cutaneous habronemiasis to the granulomatous condition produced in the external mucous membranes and cutaneous tissues by the larvae of the genus *Habronema.*

The term habronemic granuloma has been used by the present writer as the designation of the granulomatous

condition arising after the invasion of the external mucous membranes or cutaneous tissues by larvae of the genus *Habronema*. It is believed that this term is more likely to be correct than the term introduced by Railliet.

F. General Summary.

A granulomatous condition found most frequently affecting the external mucous membranes of the horse in Southern Australia has been found to be due to the presence of a larval Nematode of the genus *Habronema*. These granulomata are found less frequently on the sheath, limbs, and probably other situations. The tissue reaction following the introduction of the larva gives rise to a tumour presenting a characteristic macroscopic and microscopic appearance. The larva is often very difficult to demonstrate, and is only to be found in lesions of up to about three weeks' duration. In lesions of longer standing there is usually no evidence whatsoever of the presence of the larva, but occasionally the spaces it once occupied are to be seen. The larva is incapable of living in the submucous, cutaneous, or subcutaneous tissues, and, therefore, its presence in these tissues appears to be quite accidental. Evidence suggests that these larvae are introduced from without, and that they are deposited on moist surfaces during the feeding operations of *Musca domestica*, which fly acts as the intermediate host of both *Habronema muscae* and *H. megastoma*. When deposited on the external mucous membranes the larvae appear to be capable of pushing their way through the membrane and of entering the submucosa. When lesions occur on parts other than the external mucous membranes, the moisture necessary to prevent desiccation of the larvae appears to be most usually supplied by an exudation of blood or serum. This would follow some injury to the skin of the animal, either in the form of ordinary wounds or in the form of small puncture wounds made by biting flies such as *Stomoxys calcitrans*.

After a consideration of the life-histories of the three species of *Habronema*, it appears that the larva responsible for the production of these lesions is most commonly that of *H. megastoma*. It seems possible that the larvae of the other two species may also cause similar lesions. The results obtained by animal experimentation go to support these conclusions.

The macroscopic and microscopic appearances of a granuloma commonly called "swamp cancer" which affects horses in Northern Australia are essentially the same as those found in the granulomata occurring in Southern Australia. Evidence suggests that this granuloma is possibly due to the larva of

Habronema microstoma, which would probably be inoculated by *Stomoxys calcitrans*.

A granulomatous condition found commonly in the horse and ass in various parts of the world, and known as "summer sores," or "granular dermatitis," has the same etiology as the granulomata observed in Southern Australia.

Examinations have been made of a granuloma which affects the region of the pastern of the horse in the Solomon Islands, and it has been found to be a habronemic granuloma.

Under the names "Leeches" in North America and "Bursattee" in India are described granulomata affecting equines. These granulomata possess characteristics that are common to habronemic granulomata. No larvae have been found in the tumours, and the etiology still remains somewhat obscure. They possess, nevertheless, such a striking resemblance to habronemic granulomata that it seems probable that they possess a similar etiology.

G. Prophylaxis and Treatment.

Prophylaxis should be in the direction of (1) ridding horses of the adult forms of the genus *Habronema* which are located in the stomach, and (2) in the destruction of horse dung or its use in agriculture. Of these two methods the second is more likely to bring success than the first, and in time should accomplish what is aimed at in the first.

Excision of the lesion will usually be found the best method of treatment. Should the lesion be ulcerated and of such a size as to be inoperable it is advisable to keep the surface covered by some application which will protect it against flies and possible super-infection. The lesion may reduce in size under this treatment and become amenable to surgical treatment.

Addendum.

Since this paper was submitted an opportunity has arisen of examining the published record of the work performed by Hill (1918), of which work reference has already been made. In so far as they deal with the life-histories of *Habronema muscae*, *H. microstoma*, and *H. megastoma* the present writer's results, in the main, agree with and confirm those obtained by Hill. Hill, however, concludes definitely that *Musca domestica* "occasionally (possibly only accidentally) acts as an intermediary" host of *H. microstoma* (p. 44). His records of experiments 7 to 11, 13 and 14, where larvae of *Musca domestica* were allowed to develop in sterilized faeces to which larvae of *H. microstoma* had been added, show that

of 28 fly larvae, approximately 193 pupae and approximately 196 adults examined, only two larvae were found to contain one worm embryo each (experiments 7 and 8), and one adult one malformed larva (experiment 14). In further experiments (Nos. 15 and 16) larvae of *H. domestica* were allowed to develop in sterilized faeces to which larvae of both *H. muscae* and *H. microstoma* had been added.

In experiment 15, of 28 flies examined 15 were found infested with worm larvae. In Table 5 particulars are given of 6 larvae obtained from these flies. Hill believes that 4 of these larvae, specimens 3-6, are larvae of *H. microstoma*. The evidence in favour of these larvae being those of *H. microstoma* is not entirely convincing, particularly as the final larval stage was not observed, and the present writer doubts the correctness of Hill's conclusion.

Nevertheless, one does not doubt the possibility of *M. domestica* acting as an intermediary host of *M. microstoma*, but more evidence is required before proof of such is established.

In commenting on the present writer's preliminary observations, Hill (p. 62) casts doubts upon the results obtained in the experiments with larvae of *H. megastoma*. In these preliminary observations the opinion was expressed that it would be difficult or impossible to differentiate with absolute certainty between the final larval stage of *H. muscae* and that of *H. megastoma*.

Hill, unfortunately, failed to appreciate the fact that this opinion was expressed from the point of view of the possibility of differentiating larvae obtained from habronemic granulomata, and he further missed altogether the reference to the fact that differences had been observed, particularly with regard to the length of the oesophagus. His inference, therefore, that the present writer was not dealing with pure cultures cannot be held to be correct.

The fact that Hill (p. 64) failed to satisfy himself as to the specific determination of larvae obtained from conjunctival lesions, but considered they resembled those of *H. megastoma* more closely than those of *H. muscae*, seems to support the conclusions outlined in the present communication, *viz.*, that it would be difficult or impossible to differentiate between the final larval stage of *H. muscae* and *H. megastoma*, except under the best conditions of preservation, etc., and that evidence is in favour of the probability that larvae of *H. megastoma* are more often responsible for the production of habronemic granulomata than the larvae of the other two species.

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DESCRIPTION OF PLATES.

PLATE XIII.

Fig. 1. Photo-micrograph of a section from a lesion produced under artificial conditions by larvae of *Habronema megastoma*. A typical necrotic area is seen with a worm canal in the centre containing a degenerating larva. Tumour removed nine days after inoculation.

Fig. 2. Photo-micrograph of another portion of the section used for Fig. 1. The formation of multinucleated cells is well illustrated.

Fig. 3. Photo-micrograph of another portion of the section used for Fig. 1. A degenerating larva with no surrounding necrosis of the tissues is illustrated.

PLATE XIV.

Fig. 4. Photo-micrograph of another portion of the section used for Fig. 1. A small necrotic area is seen, and close to it a degenerating larva with only slight necrosis of the surrounding cells.

Fig. 5. Photo-micrograph of a section from a lesion produced under artificial conditions by larvae of *Habronema microstoma*. A necrotic area is seen with a degenerating larva at its lower edge. Tumour removed ten days after inoculation.

Fig. 6.—Photo-micrograph of a section removed six hours after inoculation with larvae of *Habronema microstoma*. Larvae are seen surrounded by leucocytes.

PLATE XV.

Fig. 7. Photo-micrograph of a transverse section of the bulb of the proboscis of *Stomoxys calcitrans* showing the situation of the larvae.

Fig. 8. "Swamp cancer" in the Solomon Islands. Lesions on both fore-legs of the animal are well shown.

Photo by John Scott.

THE PHAESTOS DISK: ITS CYPRIOTE ORIGIN.

By A. Rowe,
Author of "An Ancient Egyptian Coffin in the Australian Museum," etc.

[Read August 15, 1919.]

PLATES XVI. TO XXII.

The Phaestos Disk has been an enigma to archaeologists and philologists ever since it was found in Crete in 1909, for a good many attempts have been made to determine the country of its origin and to unravel the meaning of the pictorial characters appearing on it, without success. However, the present writer believes that he has at last discovered the real provenance of the Disk, and this brochure contains the results of his provisional investigations.

By far the most satisfactory paper that has yet been compiled on the matter is that which was published by Professor R. A. S. Macalister in the "Proceedings of the Royal Irish Academy," (1) and I unhesitatingly accept most of this savant's identifications of the objects represented by the signs. Since Professor Macalister's paper was written references to the Disk have appeared in various other publications, but none of them can be said to have thrown much new light upon the problem.

For the convenience of those not intimately acquainted with it, it may be mentioned that the Disk was brought to light by Dr. Pernier, of the Italian Mission, who discovered it in a part of the palace at Phaestos under circumstances which led him to believe that it was made no later than the seventeenth century B.C. It is a disk of refined clay, about ¾ in. in thickness and 6½ in. in diameter, and is covered with hieroglyphs on both faces, the words (which are separated by vertical lines) running in a continuous spiral from the edge to the centre. The characters are not inscribed on the Disk, but impressed by means of specially engraved stamps, so that each individual hieroglyph is always exactly similar to others of its kind in detail and appearance. Attention must be drawn to the important fact that the clay used is not Cretan; this was

(1) Vol. xxx., sec. C, p. 342. A copy of this paper has kindly been sent to me by its author.

established beyond all doubt by Dr. McKenzie, the well-known authority on remains of Minoan Crete.[2]

It has been generally postulated in the past that our Disk text contains a language akin to Lykian, but Professor Hempl[3] thinks it contains a form of early Greek. At the present stage of my investigations I am unable to prove whether or not the script is in either of these languages; but however, as we shall see presently, it seems more probable that the speech it represents was that of the autochthones of Cyprus, and that it may even possess a few Ionian or Assyrian words.

There is another point on which agreement has not been reached, and that concerns the direction in which the inscription is actually to be read. With the exception of Macalister and Hempl, scholars have asserted that the text was written from the centre outwards, but the reason for their statements is not at all clear, since the general rule to be followed in translating hieroglyphical writings is to read *towards* the direction in which the characters, such as men, animals, birds, etc., face. There is no evidence in the Disk to justify a departure from this rule.

In accordance with the procedure adopted by previous writers on the subject, I first tried to decipher the inscription with the aid of some Anatolian language, but made no headway. Knowing, of course, that the text was not Minoan, I looked among various other early Mediterranean writings for help, with the result that when I came to examine the linear characters of Cyprus I was at once struck with the great similarity which exists between certain of these and certain of the Disk pictorial characters.

I immediately followed up the clue thus afforded me, and in the accompanying plates, as well as in my detailed descriptions of certain signs to be given hereafter, will be seen analogies which, I think it must be allowed, prove beyond all doubt that the home of the Phaestos Disk is in Cyprus, and also that the pictographs on it are but archetypes of not a few characters of the later syllabary of the island.

Now as the object is said to have been found in the Cretan Middle Minoan III.[4] strata, this means that if its date is the

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(2) All remains of the pre-Homeric period of Crete (*i.e.*, the era before the advent of the iron-using Indo-Europeans in B.C. 1200) are termed "Minoan," after the name of the mythical king Minos, who is supposed to have once ruled in that island. The Minoan Age is really the Bronze Age of Crete, and is divided into three eras, *viz.*, Early Minoan, Middle Minoan, and Late Minoan. See Table A.

(3) "The Solving of an Ancient Riddle—Ionic Greek before Homer." Harper's Magazine, January, 1911.

(4) See Table A.

same as that of the remains discovered with it, it was made, as Dr. Pernier thought, somewhere about B.C. 1600.

We shall, however, have to forego all ideas of such an early antiquity for the Disk, as many of the signs it contains are but portraits of various animate and inanimate objects of the period of Assyrian predominance in Cyprus, *i.e.*, from about B.C. 700 to 650, when the island was governed by rulers mainly from Greece, doubtless Ionians.(5) In view of the fact that it has always been regarded as being at least a thousand years older than this era, my assertion might at first perhaps be taken to be a rash one, but I feel confident that after the reader has made a careful study of the comparisons given in this brochure, he will agree with me both as to the dating of the Disk and as to the country of its origin.

How it came to Crete we shall probably never know. Nor shall we know how it came to be interred among pottery and other remains of the last era of the Middle Minoan period. That the interment was not accidental is quite evident, but the circumstance is really one that has been lost in the mists of antiquity. In passing, it might be as well to mention that the burial of objects of a given period in tombs, dwellings, etc., of an older date was not unusual among various nations of the past; one calls to mind the vases of Chinese manufacture found in the sepulchres of Ancient Egypt.

Mr. M. Markides, the Curator of the Cyprus Museum, has kindly forwarded me particulars of the earlier and later forms of Cypriote scripts. The earlier form, termed Cypro-Minoan, from the fact that it was imported into the island by the Minoans of Crete, was in use in the Late Bronze Age (B.C. 1500 to 1200). Shortly afterwards, probably in the Period of Transition from Bronze to Iron (B.C. 1200 to 1000), Greek-speaking settlers from Greece proper, especially from Arcadia, introduced the Greek language into the island; but it seems that no inscriptions were made by them until about the eighth century B.C., when, according to Mr. Markides, the old Cypro-Minoan signs, which had been adapted for writing the new tongue, were used. This system of writing is known as Later Cypriote, and was in vogue, in the later centuries, side by side with the Greek alphabet, down to the Middle Hellenic Age.

So far there have been recovered only about 32 Cypro-Minoan signs, and I must point out that by no means all of them can be traced in the 60 linear characters of the Later Cypriote script; this circumstance certainly indicates that the

(5) For details of Cypriote history, see Table B.

Graeco-Cypriote islanders of the eighth century before our era had more than one source to draw from when compiling their syllabary, and one of these sources must have been Assyria, in certain aspects of its culture, as no inscription in the Later Cypriote script can be dated, I suppose, earlier than about the commencement of the period of Assyrian influence. I do not mean to postulate, however, that some of the new signs actually were taken from the cuneiform characters, but that the later script was pictorial in origin; certain of the older Cypro-Minoan signs (such as the building-sign, No. 1, pl. xviii.) being identified and written in their original hieroglyphical forms, and others (such as the pointed helmet-sign, No. 37, pl. xxi.) being made under Assyrian influence. This is, I believe, the way in which the new script, of which that on our Disk is a typical copy, came to be evolved; but it evidently very quickly fell into the debased style, which we know so well from the remains of the later periods of the history of Cyprus, mainly, I suppose, as a result of the more simple linear systems of writing which were spreading over the Mediterranean basin at the time. We may perhaps gather from the peculiarity that the Disk text was "printed" by means of specially engraved stamps, that the use of the new hieroglyphical script was confined to objects of clay.

From what Professor Myres states we learn that, although the majority of the inscriptions written in the Later Cypriote script can be read with the aid of Greek, not all of them can, and it is just possible that the ones we cannot decipher contain the speech of the indigenous inhabitants of the island.

The chances are that if the Phaestos Disk had never left Cyprus it would have vanished long ago, for according to Professor Sayce,[6] the fact that "no written tablets have been found by excavators in Cyprus is not surprising. In an island climate where heavy rains occur the unbaked tablet soon becomes hardly distinguishable from the earth in which it is embedded."

Particular attention is directed to the following Disk signs, the characteristics of some of which show an evident connection with those of certain objects of admitted Cypriote origin: —

Building.—(1) This is undoubtedly the equivalent of the Cypriote linear sign, "Si." Professor H. Darnley Naylor, of the Adelaide University, has suggested to me that the pictorial character represents either a dwelling of the terra-mare type or perhaps a treasure-house. The Greek language shows the

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[6] "Archaeology of the Cuneiform Inscriptions," London, 1908, p. 183.

"Si" of the Cypriote in such words as σίμβλος (beehive), which might be used metaphorically for "treasure-house"[7]; and in σῖτος (corn), and its compounds, which could readily suggest a barn. As we have to consider the possibility of some of the Disk signs being developed on the acrophonic principle from, among others, Ionian words, we must not, at this juncture, altogether reject any help from Greek sources. In Assyrian the word for treasure was "NISIRTU," and that for treasure-house "BIT-NISIRTI." The later linear sign is inscribed on a thick, heavy slab of copper,[8] figured on p. 15 in "Excavations in Cyprus" (Murray and others, Brit. Mus., 1900), so, as it is in this case, evidently a kind of treasury or foundry mark, the identification of the character with a treasure-house cannot be far wrong. On the other hand, however, it is certainly possible that houses of the lake-village type were erected in Cyprus in early times, in view of the fact that the island contains many marshes, notably those formed by the waters of the river Pedia.

Yoke.—(2) This identification was suggested to me by the President of the Society, Sir Joseph Verco, and I have every reason for believing it to be the true one.

Crested Head.—(3) As an ideograph, or even as a determinative, this sign must equal "Head," "Chief," and the like; the hieroglyph of a man's head is used in this sense in ancient Egyptian writing. The Assyrian for "head" was "ḲAḲḲADU." The value of this crested head in helping us to ascertain the age and home of the Phaestos Disk is all important. In the British Museum publication, "Excavations in Cyprus," there is depicted a beautiful ivory casket of the period of Assyrian influence in Cyprus.[9] On one side of this is sculptured a debased form of a typical Assyrian frieze, showing a king riding in a two-horse chariot, driven by a charioteer. The monarch is engaged in the pastime of slaughtering wild bulls with his bow and arrow. But what is of special interest to us is the attendant on foot who is following behind the chariot, and who is armed with an axe. This man has a crested head-dress similar in every respect to that portrayed on

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(7) Compare the "Treasuries" of Mycenae and Orchomenos.

(8) Dr. Murray says that its weight is 81 lb. 10 oz., and that an analysis made by Professor Church shows 98·05 per cent. of copper. Cyprus, of course, was the home of the copper-working industry in ancient times.

(9) See Table B of my paper. It is evident that Mr. Hall ("Ancient History Near East," 1st ed., p. 66, note 3), in dating the casket to about three centuries before this time, has overlooked the fact that the object must belong to the Assyrian era.

the Disk. Dr. Murray says of him *(op. cit.*, p. 13):—"It is noticeable that on our ivory the attendant wears a helmet identical in shape with that worn by the enemies of the Egyptians in the sea-fight figured by Rameses on the temple at Medinet Abou." These are, of course, the Philistines and the Zakkala, and the resemblance between the crested helmets of these races and the crested helmet on the Disk has led other scholars to believe that there is a Philistine element in the inscription. With this, however, one cannot now agree. Attention may also be directed to another relic of the Assyrian period of the island, and this is the magnificent silver patera from Amathus.(10) Here are seen warriors with crested helmets like those of the Disk, and round shields, attacking a fortress, one or two of the defenders of which also wear the same sort of helmet.(11)

Now the head and shield signs are at the commencement of 13 words in the inscription on the Disk, but, subtracting instances where some of these words have been written more than once, we get ten individual words prefixed by the hieroglyphs in question. There is no doubt that these two signs are ideographic determinatives, and indicate that the characters following them in the same word contain the proper name of a "Chief of the Shield," *i.e.* (probably), a commander-in-chief of an army, whose office was something like that held by the "SHUPARSHAKU" (military commandant) appointed over districts conquered by Assyria. In Assyrian cuneiform it was the custom in the majority of instances to place a determinative at the commencement of the word to which it referred, and not at the end of it, as in the case of ancient Egyptian. The scribes who made up the Phaestos Disk text seem then to have followed the *methods* of their cuneiform-using colleagues, and as a matter of fact it appears to me that the whole of the pictorial text was made mainly under Assyrian direction, although, as we have already seen, the words it contains are evidently not, so far as most of them are concerned, Semitic ones.

Sargon II., King of Assyria, received tribute in B.C. 715 from the seven Ionian Kings of Cyprus, who set up in their island a figure of the Assyrian king as an emblem of their vassalage; and his grandson, Esarhaddon, had homage paid to him in B.C. 673 by ten Cypriote princes, nine Greeks, and

(10) Figured in "Cyprus," di Cesnola, London, 1877, pl. xix.

(11) See also the helmet worn by the sphinx on the ivory object (No. 1126), illustrated in pl. ii., "Excavations in Cyprus."

one Phoenician. The names of these latter rulers are as under: —

GREEK RULERS.(12)

Assyrian form of Names.	Greek Form of Names.	City ruled over.
1. Ê-KI-IS-TU-SU	AIGISTHOS	Idalion
2. PI-LA-GU-RA-A	PYTHAGORAS	Chytroi
3. KI-I-SU	KEISOS (or, KISSOS)	Salamis
4. Î-TU-Û-AN-DA-AR	ETEWANDROS	Paphos
5. Ê-RE-Ê-SU	HERAIOS	Soloi
6. DA-MA-SU	DAMASOS	Kourion
7. AD-ME-ZU	ADMETOS	Tamassos
8. U-NA-SA-GU-SU	ONESAGORAS	Ledra
9. PU-SU-ZU	PYTHEAS	Nure (Aphrodision)

PHOENICIAN RULER.

10. DAMUSI, of the city of Kartikhadasti (Kition).

The question now arises: Can we identify these ten princes with the ten "Chiefs of the Shield" whose names are given on the Disk? It is quite possible that we can. We know for certain that the former lived towards the end of the Assyrian era on the island of Cyprus, and we have every reason for believing that the men mentioned on the Disk lived at some part of the same era. This being the case, it is hardly probable, I take it, that in such a short space of time, and in the same island, there were two different lots of men to the same number whose names were important enough to be placed on record.

As the princes of Cyprus at this time were mostly Ionians, it may well be that the crested head-dress shown on the Phaestos Disk and other Cypriote remains of the Assyrian period is a typically Ionian one. It does not follow, however, that when we can decipher the names of the ten "Chiefs of Shields" we shall find them Greek ones. As the inscription doubtless contains, in the main, the indigenous speech of Cyprus, it may just as well possess the native names which we must assume would be given to their rulers by the autochthones of the island, much in the same way as the Ptolemies had native prenomens bestowed upon them by their Egyptian subjects.

Woman.—(5) There is no doubt whatever that this sign is the equivalent of one of the symbols employed for the Later Cypriote "E." The linear character has preserved only the pendant breasts and skirts of the original sign. In words 24 and 47 the character is used as a determinative prefix indicating the name either of a queen or of a goddess, and in

(12) See Hall, "Ancient History Near East," p. 496.

word 59 it appears that we are to read the first two signs as "Chief Woman."

Rosette.—(8) This is clearly the archetype of the later 8-pointed star-shaped sign. In two words, 28 and 31, it is associated with a pictograph of an uncovered head possessing either a brand or mark on the cheek, or perhaps an ear-ring; a head similar to this is seen on the wall of the fortress mentioned above; in which case it probably typifies that of a slain captive. Now in the "Handbook of the Cesnola Collection of Antiquities from Cyprus" (13) is figured the beardless head of a male votary wearing a frontlet decorated with rosettes, the figure being of the Assyrian period of the island.(14) Are, therefore, the uncovered head and rosette on the Disk associated with the word for "votary"? On the lid of the ivory casket already referred to there are several 8-petalled rosettes. The sign is probably a direct importation from Assyria.

Boat.—(9) This may be compared with the models of Cypriote boats figured in di Cesnola's work.

Skin.—(12) This is something like the coverings placed over the horses in the chariot illustrated on the casket.

Glove.—(13) Some scholars have called this sign a cestus, but I believe it to be a glove. I communicated this suggestion to Professor W. J. Woodhouse, of Sydney University, who subsequently informed me that the character probably represented an archer's glove with a loose thumb, such as was worn by Hittite warriors. A close examination of the sign as shown in the photograph of the Disk at the end of "Scripta Minoa," vol. i., will show that Professor Woodhouse's identification doubtless is correct, for the loose thumb is there quite clearly depicted. The Later Cypriote sign, "Ke" (said by Evans to be an outline picture of a hand), may have been taken from this glove sign, for the "thumb" in the linear character is shown at right angles to the "fingers," as if to indicate that it was loose. The Assyrian for "hand" was "ḲATU." It might be of interest to add that the old Persian for glove was "KARBUL"; the latter word occurs in the inscription of Darius the Great at Nakshi Rustam, where we read of "Cimmerians who wear gloves on their hands." (15)

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(13) J. L. Myres, Metropolitan Museum of Art, N.Y., 1914, p. 194.

(14) Myres, *op. cit.*, p. 193, mentions that rosette frontlets were worn by Assyrian courtiers of the early seventh century B.C. Disks in the form of rosettes were also a feature of Assyrian planet gods in the same century. *Cf.* the "Relief of Molthai from the Age of Sennacherib," son of Sargon II., who ruled from B.C. 705-682, figured in "The Civilization of the East," Dr. Hommell (Temple Primers, J. M. Dent & Co., 1900).

(15) "Records of the Past," vol. v., pp. 151, 152.

Sheep's Head.—(19) This is remarkably like the porcelain rhyton in the form of a ram's head depicted on p. 33 and pl. iii. of "Excavations in Cyprus."

Lotus.—(26) This plant was quite commonly painted on Cypriote objects, and seems to have had a religious significance. Compare the sacred lotus tree shown on p. 95 of "Handbook of Cesnola Collection."

Cypress Tree.—(29) Professor Macalister's identification of this sign as the picture of a cypress tree is a very good one, for conventional trees of this description were a special feature of ancient Cypriote art, and in certain mould-pressed terracottas they are depicted in the centre of a ring dance in which votaries, both male and female, take part. It would appear, therefore, that the cypress was a sacred tree; in some terracottas it is degenerated into a mere club-shaped column [16] very much like the sign on the Disk. In words 1, 26, 30, 38, and 39 on the Disk it is associated with the "man" sign.

Pointed Helmet.—(37) In this sign we have another striking proof of the Cypriote origin of the Disk. Professor Myres ("Handbook," pp. 143 and 195) shows us two figures of the period of Assyrian influence, both wearing helmets of this description; the first figure is a votary, and the other a bearded male, evidently a warrior. Myres mentions that this particular head-dress is peculiar to Cyprus, and has not been found elsewhere.

Virama Mark (see pl. xxi.).—In words 1, 3, 15, 16, 19, 21, 22, 27, 34, 37, 49, 51, 52, 55, and 57 there will be observed a scratch or mark placed against the last sign; this scratch, according to Hempl *(op. cit.)*, is in form and position identical with the virama mark of Sanskrit, Venetic, and early Runic writing. It was used, in the three latter scripts, to eliminate the vowel sound from the last syllable in a word, thus reducing the syllable to a simple consonantal character.

So far, with some few exceptions, I have made no real attempt to decipher any of the words printed in the inscription on the Disk; but if we can regard the signs in words 15 and 21 as pure ideographs they may be read "horse-man," *i.e.* (probably), "charioteer." Similarly, in word 30, the first sign on account of the compact nature of the tree it represents, *i.e.*, a

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(16) "Cyprus Mus. Cat.," p. 151 (Nos. 5305-5314). See also reference on p. 86 (No. 1656) to the bearded man with long hair dancing in front of a cypress or large thyrsos, represented on an Attic red-figured lekythos of the Hellenic period of Cyprus.

cypress, doubtless indicates "close," and the like; hence the group in question might equal "close-man," or "confidential-man." These renderings, although purely conjectural, will be appreciated by those who have a knowledge of the hieroglyphical writings of ancient Egypt.

On looking at the "Catalogue of the Cyprus Museum,"[17] I was at once struck with the great resemblance which exists between the arrangement of the Later Cypriote signs in graffiti marked on two black-glazed vases (Nos. 1,952 and 1,954), and the arrangement of similar-shaped signs to be found in words 14, 20, 53, and 60 on the Disk; the two graffiti are figured in pl. xxii. of this paper. In these instances the linear signs read from left to right, and must be transliterated, according to the details of Cypriote script forwarded to me by Mr. Markides, as "NA-O-TE." No classical scholar could fail to notice that this is like the Greek word *ναύτης* "sailor," or one cognate thereto. The last sign in the group is the debased form of the "ship" hieroglyph.

The chief drawback the present writer has had to suffer from is the lack, in the Commonwealth, of books bearing on or giving complete information on the phases of Cypriote archaeology, and he has perforce had to make the best use he could of the undermentioned works, all of which, with the exception of di Cesnola's, which is in some respects out of date, are, of course, to be relied on in the main. Most of them have already been referred to in the text:—

(1) "Cyprus: its Ancient Cities, Tombs, and Temples." di Cesnola, London, 1877.

(2) A reference to Cypriote language in the article on "Alphabet," in Encyclopaedia Britannica, 11th ed. (plate facing p. 729).

(3) "Handbook of the Cesnola Collection of Antiquities from Cyprus." J. L. Myres, Metropolitan Museum of Art, New York, 1914.

(4) "A Catalogue of the Cyprus Museum." J. L. Myres, Oxford, 1899.

(5) "Formation of the Alphabet" (Petrie). British School of Archaeology in Egypt, Studies Series, vol. iii., London, 1912.

(6) "Scripta Minoa," vol. 1. A. J. Evans, Oxford, 1909.

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(17) J. L. Myres, Oxford, 1899, p. 90. The graffiti figured in pls. xviii., xix., xx., and xxi. of my paper are also taken from the page referred to.

(7) "Excavations in Cyprus." Dr. Murray and others, British Museum, London, 1900.

(8) "Annual Report of the Curator of Antiquities of Cyprus, 1916." M. Markides, Nicosia, 1917.[18]

Some of the authorities mentioned are by no means in agreement as to the values of certain Later Cypriote signs, as will be quite evident from an examination of the examples given in my plates, and it must be understood that so far as the *values* given by di Cesnola are concerned, these are incorrect in a few cases, which is not surprising when we remember that his work was compiled nearly half a century ago.

At some date in the future I hope to be in a position to attempt a transliteration, if not a translation, of the whole of the text on the Disk, but I am satisfied for the present in being able to show that, apart from the testimony afforded by my equations of the Disk signs with the Later Cypriote signs, the evidence I have quoted from sources other than that of the linear writings of Cyprus is sufficient in itself to prove that the Phaestos Disk was made there during the period of Assyrian predominance.

My thanks are due to Professor H. Darnley Naylor, of the University of Adelaide (who brought the Disk under my notice), and to Professor W. J. Woodhouse, of the University of Sydney, for the kind help and assistance afforded me during my investigations into the problem of the Disk. I must also express my gratitude to Mr. Markides, the Director of the Cyprus Museum, for the great trouble he has been put to in making for my use a copy of his list of the Later Cypriote signs, and for forwarding much valuable information on all the types of ancient writings used in Cyprus. The encouragement given me by my close friend and fellow-archaeologist, Mr. T. D. Campbell, has been of no little aid to me in the compilation of this Paper. Except where otherwise indicated, I alone am responsible for the opinions set out herein.

[18] A copy of this Report was kindly sent to me by Mr. Markides.

APPENDIX.

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Table A.—The Prehistoric Ages of Crete, The Cyclades, and Greece.

Table B.—The Prehistoric and Early Historic Ages of Cyprus.

Table A.

THE PREHISTORIC AGES OF CRETE, THE CYCLADES, AND GREECE.

Period of non-Aryan Culture.

CRETE.	CYCLADES.	GREECE. South.	GREECE. North.
Early Bronze Age. (Central date c. B.C. 3000.)			
Early Minoan I.	Early Cycladic I.	Stone Age.	Stone Age. In Thessaly, Boeotia, and Phokis, which *may* have been inhabited by Aryan - speakers, the use of stone existed longer than in South Greece. The later era of North Greece is chalcolithic (*i.e.*, bronze and stone were used side by side), and continued so until the Early Iron Age. (See "Aegean Arch.")
Early Minoan II.	Early Cycladic II.		
Early Minoan III.	Early Cycladic III.		
Middle Bronze Age. (Central date c. B.C. 2000.)			
Middle Minoan I.	Middle Cycladic I.		
Middle Minoan II.	Middle Cycladic II.		
Middle Minoan III.	Middle Cycladic III.	Bronze Age. Mycenaean I.	
Late Bronze Age. (From c. B.C. 1600-1200.)			
Late Minoan I.	(Cycladic culture now absorbed in that of Crete, and termed "Late Minoan" accordingly.)	Mycenaean II.	
Late Minoan II.	———		
Late Minoan III.	———	Mycenaean III.	

Period of Aryan Culture.

Early Iron Age.
(Commencement c. B.C. 1200.)

With the advent of the iron-using Indo--European speakers from the North the Bronze Age culture of Crete, the Cyclades, and Greece concludes, and the Homeric period commences. The Phaestos Disk was discovered among Middle Minoan III. objects.

[This table, which is entirely original in form, is compiled solely from particulars given in "Scripta Minoa," A. J. Evans, and "Aegean Archaeology," H. R. Hall, London, 1915. For the sake of convenience I have omitted the Stone Age periods of Crete and the Cyclades.]

TABLE B.

PREHISTORIC AND EARLY HISTORIC AGES OF CYPRUS.

DATES, B.C.	
?	**STONE AGE.**
	(Left few traces in Cyprus.)
	BRONZE AGE.
3000-2000.	Early Bronze Age.
2000-1500.	Middle Bronze Age.
1500-1200.	Late Bronze Age. (Parallel to XVIII. Dyn. of Egypt).
	IRON AGE.
1200-1000.	Early Iron Age. (Transitional from Bronze to Iron.)
1000- 750.	Middle Iron Age. (Geometrical, with iron weapons.)
750- 500.	Late Iron Age. (Graeco-Phoenician. The period of Assyrian predominance, artistic and political, was from c. 700-650 B.C.; but the *influence* of Assyria "may have begun a little in advance of the Assyrian protectorate. It may have lasted from 750-650 B.C." [Myres, "Handbook of Cesnola Collection"]).
	HELLENIC AGE.
500-300.	Early Hellenic Period.
300- 50.	Middle Hellenic Period.
50 B.C.-400 A.D.	Late, or Graeco-Roman Period.
	BYZANTINE AGE.
400 A.D.-1200 A.D.	(Under the Byzantine Emperors Cyprus became the seat of an Archbishopric.)

[This table is compiled solely from particulars given in the "Handbook of the Cesnola Collection of Antiquities from Cyprus," J. L. Myres, Metropolitan Museum of Art, New York. The Phaestos Disk belongs, I believe, to the period of Assyrian predominance.]

DESCRIPTION OF PLATES.

Plate XVI.

The Phaestos Disk—Face "A." Date c. 700 B.C.
Provenance—Cyprus.

Plate XVII.

The Phaestos Disk—Face "B."

Plate XVIII.

Later Cypriote Signs similar to Phaestos Disk Signs.

Plate XIX.

Later Cypriote Signs similar to Phaestos Disk Signs *(contin.)*.

Plate XX.

Later Cypriote Signs similar to Phaestos Disk Signs *(contin.)*.

Plate XXI.

(a) Later Cypriote Signs similar to Phaestos Disk Signs *(concluded)*.

(b) Phaestos Disk Signs unlike Later Cypriote Signs.

Plate XXII.

(a) Equations of miscellaneous Cypriote Drawings, etc., with Phaestos Disk Signs

(b) A typical inscription in Later Cypriote Characters, with transliteration, etc.

The Occurrence and Origin of Certain Quartz-Tourmaline Nodules in the Granite of Cape Willoughby.

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(Communicated by Professor Walter Howchin.)

[Read July 11, 1919.]

Plates XXIII. and XXIV.

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I. Introduction.

The present paper is devoted to a short description of an occurrence of some remarkable aggregates composed essentially of quartz and tourmaline with felspar, which are developed in a mass of aplite intrusive into the granitic headland of Cape Willoughby, Kangaroo Island. The paper really forms part of a more extensive study of the petrology of the Cape Willoughby granite and its allied intrusions. The publication of these data is reserved for a later date.

After a review of the occurrence, and reference to previously published descriptions of similar aggregates at other localities, the probable mode of origin of the nodules is outlined.

II. General Description of the Occurrence.

Cape Willoughby consists of a large mass of granite intruded into a series of quartzites, quartz-mica-schists, and mica-schists of probably Cambrian Age. The granite is an even-grained rock consisting of quartz, microcline, plagioclase (oligoclase-andesine), and biotite. Under the microscope the accessories are seen to be muscovite, apatite, and zircon. The most striking feature of the rock is the presence of subidiomorphic crystals of quartz showing a remarkable blue opalescence. This granite occupies an area of approximately two square miles, and has a coastline length of about five miles.

Into this granitic mass are intruded a highly interesting series of aplitic and pegmatitic rocks which are obviously

genetically related to the granite. The series comprises microcline aplites and a number of albite pegmatites (albitites), *viz.*, quartz and muscovite albitites. These rocks traverse the granite in the form of dykes, and also as irregular masses, and represent the later stages of the crystallization of the granitic magma.

The microcline aplite intrusive mass is the home of the quartz-tourmaline nodules now under discussion. This aplite, known as the "Pink Aplite," occurs as a large intrusive mass along the coast adjacent to the Cape Willoughby Lighthouse. Its intrusive nature is well marked, the junction with the granite being well defined. The mass shows a rather variable texture throughout its extent. The greater part is of very fine grain, but in part this grades into a coarser variety, in which are developed phenocrysts of blue quartz, and the ferromagnesian mineral biotite also makes its appearance.

The aplite has been fissured, and along these fissures quartz veins have been intruded. Associated with these veins occurs a zone of altered aplite consisting essentially of quartz and a light-greenish mica. This is a greisen. A further pneumatolytic change is the production along fissures of white kaolin.

At the south end of the mass there are developed, in the very fine-grained variety, numerous patches, in cross section roughly hexagonal to elliptical. On examination these patches, or nodules, are seen to consist mainly of quartz and tourmaline.

The minerals recognized in the aplite are quartz and felspar. Microscopically the minerals present are quartz, microcline, plagioclase (albite), and, as accessories, biotite, much chloritized, and muscovite. Kaolin and secondary mica accompany the felspars as alteration products. In the fine-grained varieties of aplite, biotite and muscovite are usually absent, the development of these minerals being relegated to the coarser varieties.

The aplite is remarkable for the presence of occasional granophyric phenocrysts of quartz and microcline, and micrographic intergrowth of these two minerals is displayed, more especially in the coarser varieties. In parts of the finer-grained types the fabric approaches the type "granulitic," characteristic of some aplites.

III. The Quartz-tourmaline Nodules.

These nodules, on account of their mineralogical composition, resist the attack of the normal agents of weathering

and, as a consequence, stand out in relief from the aplite in which they are enclosed. They occur apparently quite irregularly arranged in the mass, but appear with few exceptions to be confined to the finer-textured variety of the aplite.

In section, as seen on the rock face, they appear more or less elliptical, although some are really hexagonal. The form taken by the majority of the nodules is, however, an ellipsoid. In size they are slightly variable, but the greater number have diameters, approximately, of 2 in., or slightly less.

A number of thin sections of these nodules was cut, and microscopical examination showed them to consist, essentially, of quartz, felspar, and tourmaline. The nodules show the general texture of the surrounding aplite. Tourmaline is abundant, and is characteristically developed in the act of replacing the microcline and albite felspar. All stages of replacement can be traced, from the initial stages to complete replacement. Minute arms of tourmaline stretch, at intervals, through the felspar, isolating portions of the one felspar from each other, in just such a way as to prove the development of tourmaline from the felspar. The tourmaline shows strong pleochroism, and is of blue colour of varying shades, tending to brownish-green. This is the blue aluminous tourmaline characteristic of felspar derivation.[1] Minute amounts of muscovite may be associated with the tourmaline.

The process of replacement described is well shown in the microphotos which accompany this paper. Quartz is present in clear grains with minute inclusions, and the felspar still unreplaced is heavily dusted with kaolin. Some quartz, especially towards the centres of the nodules, is probably secondarily produced during pneumatolysis. In some nodules the amount of replacement of felspar grains by tourmaline becomes more complete as the centre is approached. At the centre the remnant of a felspar grain may only be represented by a shred at the periphery, or a shred in the interior of the tourmaline grain. The proportion of quartz in such cases may increase at the centre, suggestive of silica being derived from the felspar interaction.

Nodules somewhat similar to those just described have been previously noted by investigators of the Tasmanian Geological Survey. Waller[2] noted their occurrence in an aplite from Mount Heemskirk, Tasmania. More recently L. L. Waterhouse has also described similar nodules in the

(1) *Cf.* Mem. Geol. Surv. Eng. and Wales, 1909, p. 65; Scrivenor: Quart. Journ. Geol. Soc., vol. lix., 1903, p. 151.

(2) Waller: Report on the Tin Ore Deposits of Mount Heemskirk, Geol. Surv. Tas., Sept., 1902, p. 4.

Stanley River District,[3] and has examined in more detail those occurring in the Mount Heemskirk acid intrusives.[4] The descriptions given by these two investigators agree, fairly closely, with the nature of the occurrence at Cape Willoughby.

The presence of small amounts of cassiterite, the absence of felspar from the centre, and the frequent presence of a central cavity, seem to be the principal points of distinction between the Tasmanian and Willoughby examples.

In discussing the origin of these nodules, both writers reach the conclusion that the nodules represent segregations of quartz and tourmaline. To quote Waterhouse,[5] "They are due to the operation of magmatic differentiation in the original magma, the minerals now forming these nodules having gradually segregated and solidified as cooling proceeded."

Apparently, similar nodules are developed in aplites associated with the granitic batholith of the Elkhorn District, Montana, as described by Barrell.[6] Knopf also describes nodules from aplite in the same region, but south of Montana city.[7] These aplites are regarded as differentiates of the same batholith of quartz-monzonitic type, common to the Elkhorn and Helena Districts. The nodules contain quartz, orthoclase, and tourmaline; but in neither case is the relationship of the tourmaline to the felspar clearly indicated. Both Barrell and Knopf evidently regard them as segregations from the liquid aplitic magma; *e.g.*, Knopf states, "The tourmaline-quartz-orthoclase segregations are regarded as imprisoned and congealed globules of this final differentiate."

In the case of the Cape Willoughby nodules, the view that they are segregation products of earlier crystallization cannot be accepted. Microscopic and other evidence tends to show that they are, indeed, strictly pneumatolytic products. In the slides is to be seen the very act of replacement of felspar by tourmaline. The texture and composition of the nodule, apart from the presence of the tourmaline, suggests that the nodule has developed *in situ*. It has been mentioned above that the nodules are almost entirely relegated to the finer-textured variety of the main aplite. Similar circumstances surround the Tasmanian occurrences, where Waterhouse, in referring to their occurrence, says,[8] "In the field

(3) L. L. Waterhouse: Bull. No. 15, Geol. Surv. Tas., 1914, p. 28.

(4) L. L. Waterhouse: Bull. No. 21, Geol. Surv. Tas., 1916, p. 71.

(5) *Loc. cit.*, p. 28.

(6) J. Barrell: 22nd Ann. Report U.S.G.S., 1901, pp. 542, 543.

(7) A. Knopf: Bull. 527, U.S.G.S., 1913, pp. 34, 35, 53.

(8) *Loc. cit.*, p. 29.

these nodules were not observed in the coarser-grained granite; they appear to be confined to the finer-grained varieties"; and again,[9] "Their home is in the fine-grained tourmaline granite and the white granite, and it is in the former that they undoubtedly reach their maximum development."

The author, after consideration of the occurrence at Cape Willoughby, suggests that the following processes have co-operated in their production:—

The crystallization of the main mass of granite was followed by the production of fissures and joints as a result of contraction through cooling. Into these fissures was injected the still liquid residue of the magma enriched in mineralizers, and forming what are now the aplites. The sudden injection of a highly fluid mass charged with volatile products, primarily water with other mineralizers, would, the fissure being spacious enough, provide an avenue of temporary escape for the more volatile products. A magma of this nature is thus characterized by a remarkable mobility of equilibrium. It is possible that, at this stage, the principal mineralizer, water, was present, partly as a gas, below its critical temperature.[10]

The increased magma space thus originating through fissuring, the resultant effects are:—

(1) A reduction of pressure due to expansion of the gas phase; concurrently a reduction of the concentration of the volatile components in the liquid magma.

(2) An increase in the viscosity of the silicate liquid due to reduction of the active mass of the mineralizers in the liquid.

(3) Increasing the crystallization temperatures or freezing points of the silicates in solution.

[It is to be noted here that a lowering of freezing point generally accompanies a reduction of pressure, but this effect must be enormously outweighed by the decreased fusibility (solubility) consequent on diminished concentration of volatile components. This latter effect apears to have been ignored or denied by some petrologists, *e.g.*, Schweig[11] even

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[9] *Loc. cit.*, No. 21, p. 73.

[10] It does not follow from this that the temperature was below 370° C.—the critical temperature for pure water. A gas dissolved in a mixture of non-volatile components has a higher critical temperature than it possesses in the pure state. This elevation of the critical temperature is analogous to the elevation of boiling point by dissolved substances.

[11] M. Schweig: Neues Jahrbuch Beil., Bd. 17, 1903, p. 516. *et. seq.*

develops an hypothesis of differentiation of volcanic rocks in large part based on the lowering of freezing point accompanying reduction of pressure due to ejection of magmas. The phenomenon of resorption, common in phenocrysts of hypabyssal and volcanic rocks, has also been attributed by some writers to a reduction in pressure consequent on injection or eruption. There can be little doubt that this lowering, which never exceeds a few degrees per 1,000 atmospheres,(12) is enormously overweighed by the decreased fusibility consequent on removal of volatile components.(13)]

Owing to the loss of volatile constituents and to a minor degree of changing temperature, equilibrium would be violently disturbed, and the residual magma conditions would become unstable. Some of the components of the fluid previously near or at their freezing point would then become undercooled,(14) and with a magma of aplitic composition the spontaneous crystallization of quartz and felspar would ensue.

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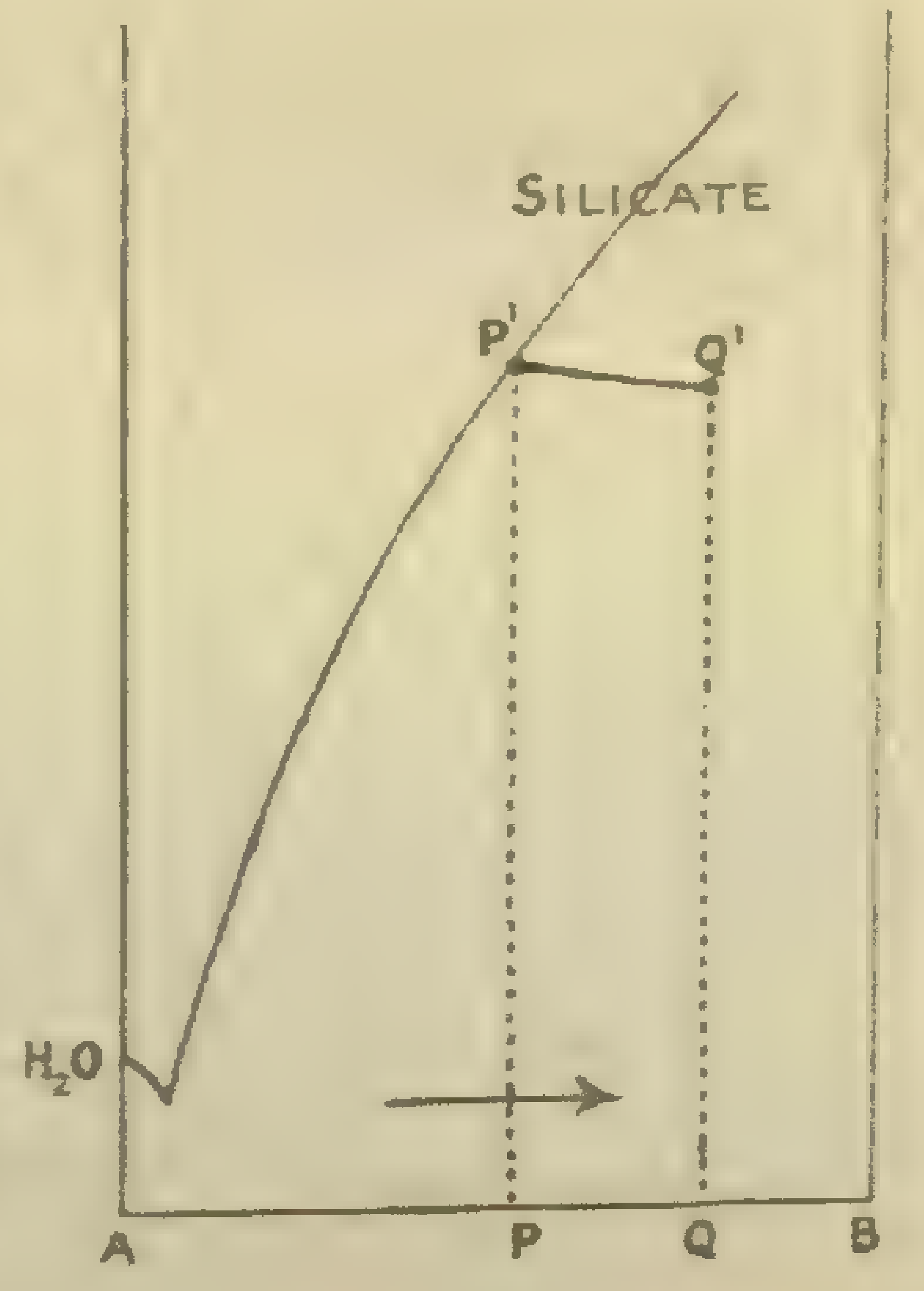
(12) Uniform pressure, of course, is postulated here. The differential effects of uniform and non-uniform pressure are discussed in detail by Johnston and Adams. Amer. Jour. Sci., 35, 1913, 205.

(13) G. Morey: Jour. Amer. Chem. Soc., pt. i., 36, 1914, 215. The influence of water at a high temperature on the melting point of silicates is well exemplified in the work of Morey on "New Crystalline Silicates of Potassium and Sodium, their preparation and general properties." The case is instanced of potassium silicate which when dry melts at 1015° C., yet yields in the presence of water in a closed vessel at temperatures of 500° C. to 400° C. perfectly fluid (liquid) solutions containing 8-25% water. The results of these experiments at high temperatures and pressures are definite, and in full agreement with the existing physico-chemical theory as applied to solutions at ordinary temperatures and pressures. There can be little doubt, therefore, that the melting depression is dependent on the concentration of the volatile component.

(14) This undercooling is clearly shown diagrammatically in the temperature-concentration freezing point curve of a binary solution water-silicate, where P = original composition of the magma and Q = changed composition of the magma. P^1 represents the magma of composition P starting to crystallize, or near the point of crystallization. The point Q^1 represents the temperature and composition of the magma which is thus undercooled, with respect to the silicate, although the temperature has but slightly changed. The illustration is, of course, purely diagrammatic, and is not complete for the solution in question (water-silicate).



On account of the viscosity the actual size of the crystals would be small, for diffusion currents would not move sufficiently rapidly to supply the growing crystal.

The conditions above described probably represent the "labile" state of undercooling, as described by Ostwald and Miers.[15] The micropegmatite, on this view, represents the composition of the hypertectic rather than the eutectic point.

Near the summit of the fissure chamber, crystallization would be initiated, as this is the point of maximum under-cooling due to the combined effects of cooling and of diminished volatile components in the liquid magma.

Concurrently with the initiation of crystallization, at the top of the fissure chamber, the reduction in pressure of the volatile phase would initiate the formation of bubbles of gas or vapour, predominantly, water dissolved in the liquid magma and other volatile mineralizers, among which were compounds of boron (boric acid). These would originate throughout the depth of the fissure chamber and, viscosity permitting, would gradually rise in the magma chamber, enlarging both by reduction in pressure during upward movement and, possibly, by coalescence of two or more bubbles. At this stage the magma chamber is pictured as filled with a more or less viscous silicate liquid, crystallization having developed at its summit and, forming a network of crystals, gradually extending downwards, and, at the same time, ascending bubbles of gases (mineralizers) present in its lower layers. With the removal of anhydrous minerals at the crystallization level, additional gases would probably be set free. The bubbles, in ascension, on reaching the network of solid crystals of quartz and felspar would attach themselves to these in the form of bubbles. The gases released on crystallization would do likewise.

The fissure magma is now pictured as a partially fluid mass containing a network of crystal silicates, some of which are enveloped in bubbles of the gas phase. It is probable that these might occupy definite restricted horizons of the fissure chamber. The volatile components present in the gas phase are assumed to have been, predominantly, water and boric acid.

With a further reduction in temperature these mineralizers take up an active rôle and enter upon a destructive stage. The felspar becomes unstable, and in an interaction with boron compounds tourmaline is produced *in situ*, the felspar being partially or completely replaced, according to

(15) *Vide* the numerous papers by Miers and his co-workers. References to these are quoted by A. Harker, Natural History of Igneous Rocks, p. 208.

the concentration of the active gases. Quartz would, of course, be unattacked; but silica would probably be released in the interaction with felspar. With a still further reduction, the remaining gases would be dissolved or condensed. The process would have initiated before final and complete consolidation took place, and the accompanying excess of alkalies, from the felspar interaction, would diffuse into the still liquid residue, partly surrounding the gaseous bubble.

For the Cape Willoughby quartz-tourmaline nodules the following data are in accord with the hypothesis outlined in the previous pages for their manner of origin:—

(1) The pneumatolytic origin of the tourmaline.

(2) The development of the nodules in, and their practical relegation to, the finer-grained variety of the red aplite.

(3) The composition and texture of the nodule in which the tourmaline is replacing the felspar is identical with that of the associated aplite.

(4) The general ellipsoidal character of the nodules.

As denoting their manner of origin, it is suggested that the name "Pneumatolith" be attached to such pseudo-segregations occurring in rocks, and which owe their existence primarily to pneumatolytic processes.

From the published descriptions of the Montana nodules previously noted, the exact relationship of the tourmaline to the orthoclase felspar associated with it is not clear, but the description of Barrell [16] is suggestive of the tourmaline being of pneumatolytic origin.

A study of the literature on the mode of occurrence of tourmaline indicates that this mineral does, occasionally, appear pyrogenetically. This is especially so where it is present as an accessory uniformly distributed through granites or aplites. It is, therefore, possible that segregations of quartz and pyrogenetic tourmaline can occur.

Through the kindness of Mr. W. H. Twelvetrees, Government Geologist of Tasmania, I have been able to obtain a number of nodules from the Heemskirk District for microscopical examination. A number of these have already been described by Waller and Hogg. [17]

The sections examined by the writer consist essentially of quartz and tourmaline, felspar being absent. Macroscopically it has been recognized in one nodule, and is represented by kaolin.

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(16) *Loc. cit.*, Sup., p. 543.

(17) Waller and Hogg: Papers Proc. Roy. Soc. Tas., 1902, pp. 143-156.

On slicing the nodules a number of empty cavities occur on the face and are distributed throughout the nodule. Whether these represent the spaces originally occupied by felspar is not clear. Under the microscope, the quartz is seen to have crystallized in well-developed crystals. Numerous sections are shown as hexagonal or rhombic. This idiomorphism of the quartz is the most striking characteristic of the slides. Consequently the tourmaline is present as grains moulded on the quartz. In some cases the moulding is developed as to yield a rude type of poikilitic fabric. Occasionally the tourmaline may also be developed in prismatic idiomorphs. The pleochroism of the tourmaline is strong, the characteristic variation being from bluish-green to light-brown yellow. In any one grain the colour variation may be considerable; this variation is, usually, irregularly developed in patches. The colour may also vary zonally.

The origin of these Tasmanian nodules is not as clearly demonstrable as of those already described from Cape Willoughby, in which the process of pneumatolysis is actually seen in progress. The evidence so far revealed, however, is that the Tasmanian nodules are essentially of miarole origin. On this view come into line:—

(1) The striking idomorphism of the constituent quartz.
(2) The presence of a central cavity in many of the nodules.
(3) The very general occurrence of cassiterite, either as a trace or in appreciable amount, and, in some nodules, of fluorite.

The nodules are thus referable to a comparatively late stage in the crystallization of the aplitic magma, rather than representing early segregation products. The associations (2) and (3), noted above, are regarded as strong evidence of their late miarole-pneumatolytic origin. The origin thus outlined, while not identical with that described for the Cape Willoughby examples, is closely analogous to it.

Summary.

I. The quartz-tourmaline nodules are developed in a mass of aplite intruding the Cape Willoughby granite.

II. The nodules consist essentially of quartz, tourmaline, and felspar (microcline and albite). The tourmaline is in process of replacing the felspar, and is evidently of pneumatolytic origin.

III. The mode of origin of the nodules is discussed, and it is shown that they cannot represent segregations of earlier formed crystals from the aplitic magma.

IV. A mode of origin, *in situ*, is suggested which is in harmony with the evident pneumatolytic replacement that has occurred.

V. As denoting their manner of origin, it is suggested that the name "Pneumatolith" be attached to such pseudo-segregations occurring in igneous rocks and which owe their existence, primarily, to pneumatolytic processes.

VI. The evidence of the Tasmanian nodules, while not as clearly delineated as in the Cape Willoughby examples, is strongly suggestive of miarole origin. Their formation is then referable to a late stage in the crystallization of the magma. The origin is distinct from the hypothesis of "segregation," and is closely related to the origin described for the Cape Willoughby nodules.

The author is indebted to Mr. W. R. Browne, B.Sc., for helpful discussion during the preparation of this paper.

DESCRIPTION OF PLATES.

Plate XXIII.

Fig. 1. Photograph of a typical quartz-tourmaline nodule. The general ellipsoid shape of the nodule is apparent. A portion of the aplite is attached to its upper rear surface. Natural size.

Fig. 2. Section of a quartz-tourmaline nodule showing the replacement of felspar by tourmaline. The tourmaline can be seen as a network through the felspar, isolating sections of the one felspar from each other. Magn. × 45 diameters.

Plate XXIV.

Fig. 1. Another section. The clear areas are quartz. Magn. × 45 diameters.

Fig. 2. A portion of fig. 1 enlarged to show the replacement of the felspar by the strings of tourmaline. Magn. × 80 diameters.

Notes on Some Miscellaneous Coleoptera, with Descriptions of New Species.—Part V.

By Arthur M. Lea, F.E.S., Museum Entomologist.

[*Contribution from the South Australian Museum.*]

[Read September, 12, 1919.]

Plates XXV. to XXVII.

Many interesting ants'-nest species are recorded in the present part, this being especially due to the efforts of Mr. J. S. Clark, in Western Australia, and Mr. F. Erasmus Wilson, in Victoria; others were also received from Messrs. W. and E. F. du Boulay (sons of the late F. du Boulay), from New South Wales and Western Australia; E. H. Zeck, New South Wales; H. W. Brown, Western Australia; R. J. Burton, A. H. Elston, and B. A. Feuerheerdt, South Australia; and F. P. Dodd and H. Hacker, Queensland.

Mr. Clark paid much attention to nests of the common twig-mount ant, *Iridomyrmex conifera*, Forel,[1] which builds mounds of small leaves and twigs that may often be fired. Shortly after he began the examination of the nests he wrote of them:—"To date I have taken home fourteen nests, ants and all, and have very carefully sieved the lot. I cannot tell you all I have found, but I have 16 specimens of *Cryptodus*, 28 *Articerus*, 7 Scydmaenidae, 2 Ptinidae, 2 (?). I feel very pleased so far, as all the specimens, except *Cryptodus*, are quite new to me. I have also examined carefully six deserted nests of the same ants, but, except the *Cryptodus*, have found nothing. With this nest I find little in the top, or mound part of the twigs; I lift it right off, and drop it into a bag, then dig the ground out a foot deep into other bags, and number all the same, and I find that most of the beetles, etc., are on the top of the ground just under the twigs, and extending not more than three inches underground." Mr. Clark subsequently examined many other nests of the species, and found in them many other true inquilines, some of which are here recorded; but he also obtained other specimens that are certainly not true inquilines, his thorough method of search rendering it probable that some of the specimens taken in the nests were victims of the ants; nevertheless, it is desirable to put on record the names of such specimens. Recently he wrote:—"I was sieving twig-mound nests most of the

(1) Name received from Prof. Wheeler.

holidays, and from two nests took 13 *Chlamydopsis inquilina*, 4 *Enasiba tristis*, 10 *Scydmaenus*, but I have not tried to count the various *Articerus*, *Ectrephes*, and Staphylinidae." Many of his takings of the Staphylinidae I hope to record at a later date; he also took some remarkable small flies and bugs.

Having recent occasion to examine many of the large wheat-stacks in New South Wales, Victoria, and South Australia, several introduced species of beetles, not previously recorded from Australia, were found in greater or less abundance; for the names of several of these I am indebted to Mr. G. J. Arrow, of the British Museum.

HYDROPHILIDAE.

Pseudohydrobius flavus, n. sp.

Flavous, some parts tinged with red. Upper-surface polished, under-surface subopaque, and very finely pubescent.

Head with small and rather dense punctures, clypeus with still smaller punctures, its suture distinct only at sides; labrum very small. Apical joint of maxillary palpi slightly longer than the subapical. *Prothorax* with slightly larger punctures than on head. *Elytra* with slightly larger punctures than on head, and with series of somewhat larger ones. Length, 3-4·5 mm.

Hab.—New South Wales: Blue Mountains (Blackburn's Collection), Wentworth Falls (A. Simson), Mount Victoria, Wollongong, Sydney, National Park (A. M. Lea), Richmond River (A. J. Coates); Queensland: Stradbroke Island (J. H. Boreham and H. Hacker), Mapleton (Hacker), Cairns (F. P. Dodd and Lea). Type, I. 8214.

Much smaller and paler than *floricola*, but with similar outlines; and, like that species, it may be taken from flowers (especially of the genus *Leptospermum*) producing nectar in abundance. The seriate punctures on the elytra are close together and moderately distinct, but not in striae, but there is a distinct sutural stria from the middle to the apex.

PSELAPHIDAE.

Leanymus mirus, n. sp.

Pl. xxv., figs. 1-3.

♂. Light castaneous, antennae (eleventh joint excepted) somewhat darker. Moderately clothed with short, pale pubescence.

Head with three small foveae or large punctures triangularly placed: two between eyes and one in front. Antennae long, first joint cylindrical, about as long as three following combined, second—tenth subequal in length, the ninth and

tenth slightly increasing in width, eleventh about as long as ninth and tenth combined and much wider. Palpi with two spiniform processes on apical joint, one on the penultimate, and two on the antepenultimate. A spiniform process also on the cardo of the maxillae. *Prothorax* strongly and evenly convex; punctures very minute. *Elytra* strongly convex; with a deep stria on each from middle of base to middle of disk, where it abruptly terminates; punctures sparse and small. *Metasternum* with a conspicuous oblique process on each side of middle. *Abdomen* with apical segment encroached upon by pygidium, this with a small fovea and several feeble nodes. Front *legs* with a spine on coxa and trochanter, femora rather stout, tibiae thin and bisinuate; middle tibiae thin, the hind ones thin and with a deep apical notch. Length 1·8-2 mm.

♀. Differs in having somewhat shorter antennae, metasternum unarmed, under-surface of abdomen not encroached upon by pygidium and legs somewhat shorter, with the front tibiae no more sinuous than the middle ones, and the hind ones not notched.

Hab.—Queensland: Cairns district (A. M. Lea). Type. I. 10650.

The processes on the metasternum are joined together at the base, at the apex each is obtusely bifid, although the cleft is very feeble on some specimens. From some directions the terminal joint of the antennae of the male appears to be regularly ovate, from others it is seen to be somewhat produced on one side of the base. The figures of *L. palpalis* (2) will give a good general idea of this remarkable insect, but it differs from that species in being smaller, apical joint of antennae paler than the preceding ones, and none black, armature of the metasternum notched, front tibiae bisinuate and hind ones notched. As on that species both sexes have the front coxae and trochanters armed. The notched hind tibiae even more clearly indicate the affinity of the genus with *Palimbolus* (*Didimoprora*), near which, despite the very different palpi, it was referred from the only other known species by Raffray; the spiniform process is so near the other part, however, that the notch could be easily overlooked. Five specimens were obtained by sieving fallen leaves at Malanda, of which one is a female, 94 other specimens, all males, were obtained at lights.

ARTICERUS SUBCYLINDRICORNIS, n. sp.

Pl. xxv., fig. 4.

♂. Dark castaneous, disc of elytra paler. Moderately clothed with short, pale pubescence, denser on metasternum

(2) Proc. Linn. Soc. N.S. Wales, 1900, pl. x., figs. 5 and 6.

than elsewhere; a few hairs on abdomen, and a conspicuous fascicle on each side of base of its upper-surface, its excavated portion glabrous.

Head rather stout and finely granulate, with a vague median line; with a short subtriangular projection from mouth. Antennae not much longer than head, feebly dilated from near base to apex, circular in transverse section. *Prothorax* subquadrate, front angles rounded off, with a fairly large top-shaped fovea, surface granulate as head. *Elytra* densely and finely punctate; subsutural striae distinct. *Abdomen* with a wide and deep excavation at base of upper-surface, the excavation widely and shallowly encroaching on middle of convex portion; its under-surface incurved from apex to base, apex strongly encroached upon by pygidium, which is foveate. *Prosternum* with a conspicuous median keel between apex and coxae. Metasternum unarmed. *Femora* moderately stout, unarmed; front trochanters feebly dentate; tibiae thickened at apex, the middle ones feebly produced at inner apex. Length, 2-2·25 mm.

♀. Differs in having slightly shorter antennae, under-surface of abdomen evenly convex, the pygidium non-foveate, metasternum less depressed posteriorly, its clothing no denser than elsewhere, and the legs unarmed.

Hab.—Western Australia: Swan River, many specimens from nests of *Iridomyrmex conifera* (J. S. Clark). Type, I. 10626.

In size and general appearance somewhat resembling *A. cylindricornis*, but there are many differences of the head, under-surface, and legs, the antennae are shorter and stouter, and are feebly dilated from the base to the apex. The metasternum of the male is flattened and somewhat depressed posteriorly, its dense clothing causes the flat space to appear conspicuously triangular, and at each corner of the base of the triangle there is a feeble fascicle that has the appearance of a small tooth. The feeble armature of the legs (confined to the middle tibiae and front trochanters) is very unusual in the males of *Articerus*.

Articerus wilsoni, n. sp.

Pl. xxv., figs. 5 and 6.

♂. Castaneous, some parts slightly darker than others, basal half of antennae darker than apical half. Clothing as described in preceding species.

Head very short, part in front of eyes slightly wider than long, a shallow depression in middle between eyes, on each side of which is a minute black elevation; surface finely granulate. Antennae circular in transverse-section, basal half narrow and

lightly curved, then strongly dilated with the apex truncate. *Prothorax* subquadrate, front angles rounded off; with a large median fovea from base to near apex; basal half granulate, apical half punctate. *Elytra* with dense and moderately strong punctures, becoming smaller posteriorly; subsutural striae distinct. *Abdomen* with a wide and deep excavation at base of upper-surface, the excavation semicircularly encroaching upon middle of convex portion; its under-surface strongly incurved from apex to base. *Metasternum* ridged along middle, the ridge terminating near apex in a small acute tooth. Front *tibiae* with a feeble tooth near inner apex; middle femora stouter than the others; trochanters strongly dentate, tibiae with a small outer tooth near middle, and a narrow flange at the outer apex, inner apex with an acute tooth almost in line with the flange; hind legs thinner than the others and unarmed. Length 2-2·25 mm.

♀. Differs in having the under-surface of abdomen convex, and the metasternum and legs unarmed.

Hab.—Victoria: Eltham, in nests of ants under stones, July and August, 1918 (F. E. Wilson). Type, I. 10627.

One of the most distinct species in the genus. In my table it would be associated with *A. hamatipes*, on account of the middle tibiae, but the armature is very different: on that species it consists of a conspicuous dentiform flange about the middle, on this species there is a small median tooth, but the apex is armed both internally and externally; the tooth of the front tibiae is feeble and invisible from most directions, it is also partly concealed by clothing. The fascicles on the upper-surface of the abdomen are rather larger than usual, and on its under-surface there are some small, median ones that from some directions look like small teeth. The two minute black spots between the eyes are fairly distinct; similar spots may be traced on most species of the genus. The only female examined has been returned to Mr Wilson, together with one of the males.

Articerus mesosternalis, n. sp.

Pl. xxv., figs. 7 and 8.

♂. Rather dark castaneous, disk of elytra somewhat paler. Clothing as described in *subcylindricornis*.

Head moderately long and (except for eyes) almost parallel-sided, densely granulate. Antennae rather thin and cylindrical, circular in transverse section, apical portion slightly dilated and truncate. *Prothorax* subquadrate, front angles rounded off; with a comparatively small and narrow medio-basal fovea: granules as on head, but punctate about apex. *Elytra* densely punctate; subsutural striae distinct.

Abdomen with a large deep excavation at base of upper-surface, its middle semicircularly encroaching upon middle of convex portion; under-surface slightly incurved from apex to base, apex encroached upon by pygidium, the latter with a subtriangular fovea. *Mesosternum* with an acute subconical process between coxae. Metasternum convex along middle, but unarmed. Middle *tibiae* with a small subtriangular process at inner apex, legs otherwise unarmed. Length, 1·75 mm.

Hab.—Western Australia: Beverley, from a nest of a small black *Iridomyrmex* (E. F. du Boulay). Type (unique), I. 10644.

Somewhat like *A. femoralis* on an enlarged scale, or *A. subcylindricornis* on a reduced one; from both readily distinguished by the armed mesosternum. From some directions there appears to be a feeble shining median line on the head.

ARTICERUS DUBOULAYI, Waterh.

Pl. xxv., figs. 9 to 12.

Mr. E. F. du Boulay has recently taken at Beverley specimens of a species that appears to be *duboulayi;* they differ in some respects, however, from the original description and figure (it is to be noted also that the figure differs in some respects from the description). In the figure the fovea on the pronotum only represents its deepest part, it really occupies about half the width, and more than half the length of that segment. The antennae and front legs agree from some directions with the figure; but, as noted by Waterhouse, the former look very different from other points of view. The femora of the male were described as "much incrassated in the middle and somewhat compressed" but they are not so figured, and on the males before me it is only the middle femora that are much incrassated, and they are also bidentate. The hind tibiae from some directions agree with the description, but from others they are seen to be armed with a tooth behind the insertion of the tarsi, as a result, from some directions, the apex appears bifid; the apical portion is also clothed with golden hairs. The front and hind trochanters are briefly dentate, the middle ones are unarmed. The metasternum is ridged along the middle, the ridge becoming acute posteriorly, and shortly before its apex armed with a small tooth, on each side of the ridge the surface is strongly depressed. The under-surface of the abdomen has a depression on each side of the base, with a ridge between; between the apex of the ridge and the pygidium is another depression; there are also a few small fascicles. The female differs from the male in having antennae shorter, straighter, and without subapical notch, metasternum and under-surface of abdomen evenly convex,

and the upper-surface of the latter less conspicuously notched at the sides, legs unarmed and middle femora no stouter than the others. The strongly-inflated middle femora of the male associates the species with *tumidus* in my table, but the two species are otherwise very dissimilar.

ARTICERUS CONSTRICTIVENTRIS, Lea.

Specimens of this species have recently been taken by Mr. R. J. Burton in South Australia (Murray River) and by Mr. W. W. Froggatt in New South Wales (Hay). The male, hitherto unknown, differs from the female in having the pygidium encroaching upon the under-surface of the abdomen, and this is widely, shallowly, and somewhat irregularly depressed along the middle; the metasternum is convex along the middle, the convexity abruptly declivous posteriorly, and marked at its summit by a short process that is almost concealed by golden pubescence, the front tibiae are armed by a minute apical tooth, and the hind ones have a long apical bristle (both middle tibiae are missing from the only male before me).

ARTICERUS PASCOEUS, Sharp.

Mr. E. F. du Boulay has taken several specimens of this species in ants' nest at Beverley (Western Australia). In my table the male is noted as having "front tibiae conspicuously armed at apex." This is the case when both tibiae and tarsi may be seen clearly, but when the tarsi are pressed close to the apical tooth the latter might easily be mistaken for the former. Mr. Clark also took a specimen from the nest of a species of *Cremastogaster* near the Swan River.

ARTICERUS CURVICORNIS, Westw.

Specimens taken by Mr. F. P. Spry at Coburg and by Mr. H. W. Davey at Ararat (both in Victoria) differ from the normal form of *curvicornis* in having the antennae noticeably thinner, the prothorax somewhat wider, with the fovea somewhat shorter, and the oral seta of the male shorter, the clothing in general has also a more sericeous appearance; but I can find no positive characters of the legs that would warrant their specific separation.

ARTICERUS FOVEICOLLIS, Raffr.

Mr. J. S. Clark has taken specimens in abundance in nests of *Iridomyrmex conifera* about the Swan River, that probably belong to this species, despite some apparent discrepancies. In the description the antennae are noted as "capite plus duplo longiores," and they are so figured; but on the specimens before me, on careful measurement,

they are seen to be less than twice as long as the head; they are also less conspicuously narrowed to the base than in the figure; the head is of peculiar shape, but the figure rather exaggerates the basal enlargement. In both sexes the four front femora are moderately angulate, the hind ones feebly so. The male differs from the female in having the antennae slightly longer, the prothoracic hump slightly more pronounced, the under-surface of abdomen incurved from apex to base (instead of strongly and evenly convex) with the pygidium encroaching upon it; the middle trochanters have an acute spine, and the middle tibiae have a short produced spur at the inner apex. In my table it would be associated with *fortnumi*, which is a much smaller and otherwise very different species.

ARTICERUS NITIDICOLLIS, Raffr.

Mr. F. E. Wilson has taken two females of this species in Victoria (Lorne) in October, in nests of *Ectatomma metallicum*, and of a small black species of *Iridomyrmex*.

A. FORTNUMI, Hope. *Hab.*—Parachilna, Mount Lofty Ranges.

A. DILATICORNIS, Westw. *Hab.*—Fern Tree Gully, Coburg.

A. DENTIPES, Lea. *Hab.*—Parachilna.

A. IRREGULARIS, Lea. *Hab.*—Coburg.

Now knowing *duboulayi*, *foveicollis*, and the male of *constrictiventris* additions to my table[3] of males may be given as follows:—

a.
- r. Pronotum highly polished ... ... *nitidicollis*
- rr. Pronotum subopaque ... ... *constrictiventris*

dd.
- s. Eyes on widest portion of head ... ... *fortnumi*
- ss. Eyes on narrowest portion (excluding neck) of head ... ... *foveicollis*

ff.
- t. Antennae gradually increasing in width from near base ... ... *hamatipes*
- tt. Apical half of antennae suddenly becoming much thicker ... ... *wilsoni*

gg.

ggg.

Metasternum unarmed posteriorly.
- u. Mesosternum with an acute projection between middle coxae ... ... *mesosternalis*
- uu. Mesosternum not so armed ... ... *subcylindricornis*

B.
- v. Antennae no longer than head ... ... *tumidus*
- vv. Antennae as long as head and prothorax combined ... ... *duboulayi*

(3) *Ante*, 1918, pp. 242, 243.

TRICHOPTERYGIDAE.

Rodwayia intercoxalis, n. sp.

Pl. xxv., fig. 13.

Dark castaneous, apical portion of elytra, abdomen, antennae, and legs much paler. Length, ·6 mm.

Hab.—Queensland: Cairns district, from nests of ants (F. P. Dodd). Type, I. 10682.

The outlines and punctures of this species are practically the same as in all others of the genus, and in agreement with the comments on *ovata*,(4) and the clothing consists of very short depressed pubescence, giving the upper-surface a finely sericeous appearance as on most of them; but it is darker than any other species; the abdomen is not entirely covered by the elytra, and the apical parts of the latter in consequence appear considerably paler than those parts that cover the former, but the colour of the elytra, apart from this, seems to gradually become paler from the base to the apex. The intercoxal process of the prosternum, which at first glance appears to be black, is wider than in any other described species of the genus, and its front end (the sides of which, however, I have been unable to see clearly on any of the specimens examined under the microscope) appears to be without the flange-like processes of the other species; its hind end is more obtusely notched than in any other species, except *ovata*, and each side is finely margined. The host ant is a reddish stinging species of the genus *Amblyopone* or near thereto.

Rodwayia orientalis, Lea.

I recently took this species at Glen Innes (in abundance from nests of *Camponotus nigriceps* and of *C. aeneopilosus*), Peak Hill (from nests of *Camponotus novae-hollandiae* and of a small black hairy *Iridomyrmex*), in New South Wales; and at Brisbane (from a nest of *C. aeneopilosus*), Mungar Junction (form a nest of *Ectatomma metallicum*), and Mount Tambourine (from nests of *E. metallicum* and *Polyrhachis ammon*), in Queensland.

Rodwayia minuta, Lea.

Mr. E. L. Savage took a specimen of this species from an ants' nest on Mount Lofty in April, 1917; this being the only specimen of the genus I have seen from South Australia, although it has been repeatedly searched for in nests of species of *Polyrhachis*, *Ectatomma*, and *Iridomyrmex*, in which specimens may be obtained in abundance in New South

(4) Tas. Nat., 1907, p. 16.

Wales, Victoria, and Tasmania. I also took many specimens of *minuta* from the nest of a small variety of *Ectatomma metallicum*, on Mount Tambourine in Queensland.

HISTERIDAE.

Chlamydopsis inquilina, Lewis.

Many specimens taken by Mr. J. S. Clark about the Swan River from the nests of *Iridomyrmex conifera* appear to belong to this species; they agree well with the original description, but differ from the figure subsequently given in having the elytra across the epaulettes wider than any other part, instead of (as in the figure) narrower than across the middle; the difference may be sexual or due to inaccuracy of the figure. The deep notch in each epaulette, combined with the inconspicuous punctures and striae on most of the upper-surface, and the strongly and evenly elevated sides of prothorax, render the species extremely distinct.

In a note on the species[5] a letter from Mr. Lewis was quoted recording the type as from Liverpool, in New South Wales; in the original description it was noted as from "Australia," and taken by du Boulay. Liverpool was probably noted in error, for, so far as I am aware, the late Mr. F. H. du Boulay was never there, whereas he did a lot of collecting from ants' nests in Western Australia.

Chlamydopsis comata, Blackb.

Mr. Elston has presented to the Museum a specimen of this fine species; he obtained it from a nest of *Ectatomma metallicum* (adjacent to a termite's nest) on the Mount Lofty Ranges.

Chlamydopsis excavata, Lea.

Mr. W. du Boulay took two specimens of this species (now first recorded from the mainland) from a nest of *Ectatomma* at Hunter Hill (near Sydney) in October.

Chlamydopsis tuberculata, Lea.

Three specimens of this species were taken at Lorne (Victoria) by Mr. F. E. Wilson, from nests of a small black species of *Iridomyrmex*; one specimen was presented to the South Australian Museum, and another to the National Museum.

Chlamydopsis agilis, Lea.

A specimen of this species was taken at Nairne (South Australia) by Mr. W. L. Burton, from a nest of *Ectatomma metallicum*.

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(5) Proc. Roy. Soc. Vict., 1912, p. 72.

Chlamydopsis latipes, n. sp.

Pl. xxv., fig. 14.

Dark castaneous-brown, some parts (the metasternum and abdomen quite) black.

Head immersed in prothorax when at rest, face with shallow reticulate punctures. Antennae moderately long; scape curved at base, greatly dilated towards apex, outer portion with punctures as on face; funicle short, apparently six-jointed; club long and subcylindrical. *Prothorax* strongly transverse, front margin lightly elevated behind head, then with a strong oblique elevation to each side, sides scarcely elevated and somewhat sinuous, with a subconical tubercle in middle; with dense reticulate punctures; a narrow submarginal line at base. *Elytra* about as wide as long; most of surface shining and with minute (scarcely visible) punctures; epaulettes strongly raised and with punctures somewhat as on prothorax, a strongly elevated process between each epaulette and the suture, the process wide at the base, pointed at the apex, and with a conspicuous fascicle of golden red bristles, meeting a similar fascicle on a strong median elevation, the fascicles crossing a deep transverse subbasal impression, but between it and base a less depressed space with rounded outlines; outer walls with strong striae. *Prosternum* and mesosternum with punctures as on pronotum; metasternum shining, with a narrow median line; with small and not very dense punctures. *Abdomen* with punctures as on metasternum, pygidium and propygidium subopaque, and with much denser punctures. *Legs* long; femora densely punctate, grooved on one side throughout their length; tibiae wide and compressed, grooved on lower edge to fit into femora, with a shallow groove on inner side on the upper half for reception of tarsi, the grooves with an irregular fringe of setiferous granules, front ones dilating to about basal third, where there is a small tooth, then slightly diminishing to apex; the other tibiae wider and without the tooth, but otherwise somewhat similar. Length, 3·6 mm.

Hab.—Western Australia: Mount Henry, from a nest of ants (*Dolichoderes (Hypoclinea) scabridus*, Mayr.[6]), J. S. Clark. Type (unique), I. 10675.

With the reticulated pronotum and polished parts of elytra as in the Tasmanian *excavata*, to which it is closer than to any other known species, but much larger, and basal parts of elytra, including the epaulettes and their clothing, very different, tibiae even more dilated, etc. The tubercle on the pronotum is quite distinct when viewed from the side,

(6) Name received from Prof. Wheeler.

but is much smaller and otherwise different to that of *tuberculata*. When the head is extracted from the prothorax it may be seen that the latter has a large excavation or fovea, partially invisible from above, for the reception of each antenna. At first glance the elytra appear to have two large, round, deep foveae, but this is due to the crossing of the fascicles over the subbasal excavation, and to the sinuation of the epaulettes at the sides of this, where also there are membranes with stiff bristles, these somewhat shorter than the fascicles; the excavation is without lateral openings, but there is a shallow depression (representing them) on each side, to which the striae are directed.

CHLAMYDOPSIS STRIATIPENNIS, n. sp.

Pl. xxv., fig. 15.

Black; elevated front margins of prothorax, antennae (club infuscated), and legs reddish-castaneous.

Head immersed in prothorax when at rest; face with shallow reticulate punctures. Antennae not very long; scape curved at base, thickened to apex, with punctures as on face; funicle short, apparently six-jointed; club moderately long and subcylindrical. *Prothorax* strongly transverse, front margin narrowly elevated behind head, then more strongly elevated and curved to margins, narrowest at base; with dense reticulate punctures, in places becoming substriate. *Elytra* about as wide as long, closely but sharply striated; base much and suddenly wider than prothorax; epaulettes strongly raised, and crowned with stiff reddish bristles; subbasal impression not very large (in comparison with other species), its deepest part highly polished, not indicated on the sides; tips with numerous short setae. *Prosternum*, mesosternum, and parts of metasternum and abdomen with dense subreticulate punctures, elsewhere with small ones. *Pygidium* and propygidium with dense reticulate punctures, and numerous short setae. *Legs* long; femora thin, grooved for partial reception of tibiae; front tibiae rather thin at base, then strongly thickened, a small tooth marking the termination of the tarsal groove; middle tibiae slightly longer, rather less stout, and with the dentiform projection almost obsolete; hind tibiae longer, still less stout (but with the apical half still fairly thick), and without a dentiform projection. Length, 2·75 mm.

Hab.—Victoria: Lorne, from a nest of a small black *Iridomyrmex* in October (F. E. Wilson). Type (unique), I. 10676.

A strongly striated species, readily distinguished from all others of the genus by (in combination) great width across

the shoulders, compared to the prothorax, epaulettes crowned with stiff reddish setae (not attached to a membrane), and by the greatly thickened front and middle tibiae. In my table it would be associated with *ectatommae*, which is a much smaller species, with very different legs. The elytra are strongly striated throughout, except at the bottom of the subbasal depression, the striae are mostly longitudinal, but many are oblique or sinuous, and a few near the base are transverse: on the outer walls they are not all directed towards a central point.

Chlamydopsis carinicollis, n. sp.

Black, antennae and legs castaneous.

Head immersed in prothorax when at rest; face with shallow reticulate punctures, and with two short longitudinal carinae, each ending in a small subconical tubercle. Antennae rather short; scape curved, strongly thickened, with punctures as on face; funicle short, apparently six-jointed: club long and subcylindrical. *Prothorax* strongly transverse, front margin lightly elevated and bilobed behind head, thence to sides strongly elevated and curved, sides behind where the margins join almost parallel, a narrow carina from apex to middle, a small tubercle on each side of and in line with its end, between each tubercle and the basal angles a short transverse carina, two small medio-basal tubercles; with dense, reticulate punctures. *Elytra* not much wider than prothorax, slightly wider than long; epaulettes moderately elevated; with a fairly large subbasal depression, extending almost to but not opening on to outer walls, and with a golden membrane overhanging it from the inner end of each epaulette, a narrow transverse carina on each at the apical third, extending to the outer wall but not to the suture; punctures, almost throughout, much as on pronotum. Middle parts of *metasternum* and of abdomen shining and with rather small but distinct punctures, rest of under-surface reticulate and subopaque. *Propygidium* with a short longitudnal carina, and with a transverse one at its junction with pygidium. *Femora* rather long and thin; tibiae strongly compressed, front ones with a strong tooth in middle, thence rapidly diminishing to each end, middle ones somewhat similar but the tooth less projecting, hind ones with greatest width slightly beyond the middle, the space between it and base quite straight (on the other tibiae it is distinctly curved), tarsal grooves on oblique outer edge. Length, 2 mm.

Hab.—Victoria: Beaconsfield, from a nest of *Aphaenogaster longiceps*, in July (F. E. Wilson). Type (unique), I. 10677.

A suboblong black species, with a median carina on the pronotum as in *serricollis* and *pygidialis*, to which it is allied, but from both of which it differs in many respects. Seen obliquely from behind the middle portion of the basal depression appears to have some coarse punctures, the parts beyond the membranes appear to be almost circular and highly polished.

Chlamydopsis compressipes, n. sp.

Castaneous.

Head immersed in prothorax; face with shallow reticulate punctures. Antennae rather short; scape curved, its apical half thick, with punctures as on face; funicle short, apparently six-jointed; club subelliptic. *Prothorax* strongly transverse, front margin slightly elevated behind head, thence to sides strongly elevated and lightly curved, sides feebly elevated and slightly curved, middle gently elevated and with a short feeble transverse carina; with shallow, reticulate punctures. *Elytra* slightly but distinctly wider than long, suddenly much wider than prothorax; epaulettes raised and rounded, with punctures as on pronotum, close to the inner side of each epaulette a narrow ridge conspicuously elevated above it, a small upright fascicle between its hind end and the margin; basal depression wide, deep, and semidouble, its ends partly concealed in places; with elongate, subreticulate punctures in middle, changing to simple striae; outer walls with numerous striae, all converging to a rather large but shallow fovea. Most of *metasternum* and of abdomen shining and with small punctures, rest of under-surface, pygidium, and propygidium opaque and with punctures as on pronotum. *Legs* long, thin, and compressed. Length, 2·25 mm.

Hab.—Queensland: Mount Tambourine, taken from a nest of ants in December (H. Hacker). Type (unique) in Queensland Museum.

At first glance fairly close to *epipleuralis*, with which it would be associated in my table of the genus, but readily distinguished therefrom by the epaulettes and tibiae; on the present species each epaulette is conspicuously raised, and at its greatest elevation is not disconnected with the part behind it, and its side has a round fovea not connected with the basal depression, although in line with it; the inner process near each epaulette is also terminated by a narrow ridge elevated above it; the tibiae have the outer outline gently rounded off, instead of angulate in middle; *pallida*, with somewhat similar tibiae, has very different epaulettes. The elytra are distinctly wider than long, and at the base are

much and suddenly wider than the prothorax; the legs, and especially the tibiae, are strongly compressed, so that although fairly wide they are thin, with the outer part of each tibia semi-transparent. From the species, *atra*, previously recorded from Mount Tambourine, it is distinct by its pale colour, and very different epaulettes and legs.

COLYDIIDAE.

Euclarkia, n. g.

Head irregular, about as long as wide. Eyes small and lateral. Antennae short, stout, three-jointed, first joint small and almost concealed, second very short, third cylindrical, its apex truncated. Palpi small, only apical joint of each exposed. *Prothorax* subquadrate, strongly costate. *Scutellum* small. *Elytra* closely applied to prothorax, strongly costate; epipleurae rather wide and parallel-sided to base of abdomen, thence narrowed to apex. *Metasternum* elongate; episterna rather narrow and parallel-sided. *Abdomen* composed of five segments, first and fifth subequal in length, second much shorter, third slightly shorter than second, and fourth than third. *Legs* short and fairly stout; front and middle coxae moderately separated, the hind ones more widely so; femora edentate; tibiae angularly dilated to beyond the middle, and then strongly narrowed to apex; tarsi with claw-joint almost as long as the rest combined, claws simple.

This remarkable genus is clearly allied to *Kershawia*, and in general appearance the species described below quite strongly resembles *K. rugiceps* on a small scale; with antennae removed there is no strong distinguishing feature. The antennae at first glance appear to be but one-jointed, but a very small basal joint (invisible from above) may be seen, and a second one applied like a thin disk to the base of the third, the latter has its apex slightly concave, and filled with sensitised pubescence as in so many inquilines. The mandibles are tightly clenched on all the specimens before me. Only four distinct tarsal joints are visible. The elytral episterna and base of abdomen on each side are somewhat depressed for the partial reception of the hind legs when at rest. Wings are present.

Euclarkia costata, n. sp.

Pl. xxv., fig. 16.

Rather narrow, depressed, opaque, with dense punctures all over. Brown or black.

Head truncated in front, sides incurved from between antennae to eyes, beyond each of these a subconical projection.

and then narrowed to base; surface with about eight small elevations. *Prothorax* with six narrow costae from base to apex, the two median ones somewhat incurved at middle, the outer one on each side marginal. *Elytra* with narrow costae on prothorax; with geminate rows of rather strong punctures. Length, 3-3·75 mm.

Euclarkia costata, Lea.

Hab.—Western Australia: Swan River, from nests of the twig-mound ant, *Iridomyrmex* (J. S. Clark). Type, I. 10651.

About half of the specimens are of a dingy black, the others vary to a rather light brown, but the apical half of the antennae is usually paler than the basal half, the two shades of colour being frequently rather sharply defined. On the elytra (counting the sutural thickening as the first) the second costa is continuous from base to apex, but near the apex is joined by another representing the third and fourth, these joined together slightly beyond the middle, the fifth is joined to the third at the base, but its apex is free and subapical, the marginal costa is strongly curved at about the basal third; the sutural costae appear as one, except near the base, where they narrowly diverge. A very slow-moving species, of which Mr. Clark obtained numerous specimens by sieving. It is one of the most interesting of the many curious species recently taken by him from nests of the twig-mound ant.

MYCETOPHAGIDAE.

Litargus balteatus, Lec., Proc. Ac. Phil., 1856, p. 14.

Mr. Froggatt and I obtained numerous specimens of this species in some damp wheat bags at Enfield, near Sydney. I am indebted to Mr. G. J. Arrow for the name of the species, now first recorded as occurring in Australia.

SCARABAEIDAE.

Bolboceras quadrifoveatum, n. sp.

Pl. xxv., fig. 17; pl. xxvi., fig. 44.

♂. Castaneous, tips of some processes black. Underparts densely pilose.

Head with a strong, erect, densely punctate central horn; front face of clypeus semicircular and vertical, each side narrowly carinate, and just before the canthus appearing as

a small subconical tubercle; mandibles not notched near apex. *Prothorax* with four strong processes projecting forwards, and almost equi-distant at their tips, front margin with a narrow impression across middle, becoming foveate at each side, front angles acutely produced; with a large deep fovea close to each submedian horn; with a few large punctures about middle, becoming crowded towards and on sides; basal gutter with punctures throughout. *Scutellum* impunctate. *Elytra* with small punctures in striae, of these the thirteenth and fourteenth very close together near base. Front *tibiae* with six teeth, hind pair with two wide carinae. Length, 20-21 mm.

Hab.—Queensland: Chillagoe (J. S. Clark). Type, I. 10659.

The apex of the prothorax is bifoveate, the foveae, however, lateral, but as the hind tibiae are not multicarinate Blackburn no doubt would have referred it to the first subgroup of group two, and it would there be associated with *froggatti* and *armigerum*, from the description of the former it differs in being smaller, and with the median processes of the pronotum closer together than in *tenax*, instead of more distant; from *armigerum* it differs in having the lateral processes of the head much shorter and the median horn much longer, the discal foveae of the prothorax are also considerably larger, but the horns are somewhat the same; with the heads removed specimens of the two species would probably be thought to belong to but one species; *tenax*, also with four transversely placed horns, has them more widely separated, the foveae smaller and deeper, and the cephalic horn bifid. The cephalic horn is about as long as the distance across the canthi; the prothoracic horns are somewhat compressed laterally, and rather obtusely pointed, the median ones are shorter than the one on the head, and somewhat longer than the lateral ones; in addition to the large punctures on the prothorax there are numerous minute indistinct ones. A second specimen is considerably darker than the type; its head and prothorax being dark brown.

Bolboceras bispinicolle, n. sp.

Pl. xxv., figs. 18 and 19; pl. xxvi., figs. 45 and 46.

♂. Pale castaneous, tips of some projections black. Under-parts densely pilose.

Head gently concave in middle, with two feeble subnodular elevations near base, in front with two strong spines projecting forwards and upwards, a narrow carina connecting the spines, and another connecting each with the canthus: mandibles gently incurved near apex, the right one notched.

Prothorax widely declivious but not excavated in front; about one third from base with two strong curved spines or thin horns, at the outer base of each a large fovea shallowly connected with the small sublateral one; sides finely and acutely serrated; a few punctures obliquely placed behind each eye near apex, some at sides and others in basal gutter, elsewhere impunctate. *Scutellum* impunctate. *Elytra* with narrow punctures in striae. Front *tibiae* with five teeth, hind ones with two wide carinae. Length, 19 mm.

♀. Differs in having the head with more numerous punctures and granules, front face of clypeus crowned with four equi-distant subtriangular elevations; prothorax unarmed, with coarse irregularly distributed punctures, sublateral foveae smaller and the median ones absent, and with a rather short (not the width of the head) transverse bisinuate carina about one-third from apex.

Hab.—Western Australia: Geraldton (J. S. Clark). Type, I. 10660.

Allied to *frontale*, and with the head of the male somewhat similarly armed, but the spines of the prothorax are thinner and more divergent, and the large foveae or excavations are differently placed: on the present species each is subbasal and encroaches upon the hind part of a submedian spine, its nearest part to the margin being about twice its width; on *frontale* the excavations are considerably larger, some distance from the median armature, and each opens out on to a front angle; the females of the two species are very similar. The head of the male before and behind the frontal spines has numerous small subobsolete granules, elsewhere it is smooth and almost or quite impunctate.

Bolboceras triunum, n. sp.

Pl. xxv., fig. 20; pl. xxvi., fig. 47.

♂. Pale castaneous, tips of some projections infuscated or black. Under-parts densely pilose.

Head mostly flat, smooth near base, rather densely granulate elsewhere, front face of carina short, its middle crowned with a small tooth, this connected by a carina with a smaller tooth just above each antennal notch; each mandible with an almost rectangular notch, the front edge truncated. *Prothorax* with three rather small elevations arising from a fairly large common base, the median one carinated in front, a curved carina feeble but well defined and close to base in middle, and obscurely ending on each side between the elevations and the small sublateral fovea; sides finely and rather obtusely serrated; punctures crowded towards sides, irregular in front and sparse elsewhere.

Scutellum with minute punctures. *Elytra* with small round punctures in striae, of the latter the thirteenth and fourteenth conjoined near base. Front *tibiae* with six teeth; hind ones with two wide carinae. Length, 16-17 mm.

Hab.—Western Australia (J. S. Clark). Type, I. 10658.

Allied to *trituberculatum*, and with the head very similar, but the three prothoracic elevations much smaller, closer together, in line with each other (instead of the median one considerably in advance of the others) and arising from a common base.

Rhopaea.

The species of this genus, although of large size, are very difficult to separate on superficial examination, and this difficulty is increased by the considerable variation that appears to be common in the individuals of several species. Thus *verreauxi* varies in a fashion that is almost exactly paralleled by *magnicornis* and *assimilis* (with the antennae missing it would be difficult, I believe often *impossible*, to be sure of the identity of specimens of these species); *morbillosa* is closely resembled by *mussoni*, *rugulosa*, and *polita*; *hirtuosa* by *decipiens*, etc. But the table given by Blackburn [7] readily permits of the genus being split up into distinct and easily recognizable groups.

Rhopaea nigricollis, n. sp.

Pl. xxv., fig. 22; pl. xxvi., fig. 49.

♂. Of a dingy and rather pale castaneous-brown, sterna and parts of legs darker, head, prothorax, and scutellum black, antennae flavous. Closely covered with short, depressed, ashen pubescence, mixed with a few longer hairs, these fairly numerous on prothorax; sterna densely pilose.

Head rather strongly convex and with crowded punctures between eyes, becoming much larger and sparser on clypeus. Antennae ten-, flabellum seven-jointed, first joint of the latter very little shorter than the others. *Prothorax* apparently about twice as wide as long, sides strongly rounded and obtusely serrated, all angles rounded off, median line shallow and incomplete; with crowded but not very large punctures, and with some larger ones scattered about. *Scutellum* with crowded punctures. *Elytra* with vague remnants of discal costae; with small dense punctures, often finely wrinkled or transversely confluent, and with numerous considerably larger and deeper ones. *Pygidium* densely punctate and shagreened. Front *tibiae* strongly tridentate, the second tooth much nearer the first than third. Length, 18-20 mm.

(7) Trans. Roy. Soc. S. Austr., 1911, p. 189.

Hab.—Western Australia: Beverley (E. F. du Boulay). Type, I. 10792.

The sides of the prothorax are obscurely diluted with red. There is a rather dense fringe of hairs overlapping the base of the scutellum. The prothorax measures 8 × 5 mm., but to the eye it appears twice as wide as long. Of the species referred to AA, in Blackburn's table, it differs from *soror* in being much smaller and darker, prothorax with larger punctures, and third joint of the antennae of different shape; *heterodactyla* is a larger and paler species, and its third antennal joint has a spiniform process; in *hirtuosa*, *pilosa*, and *australis* the clothing of the head and prothorax is very different; in *assimilis* the third joint of the antennae is much longer, and the fourth of very different shape: from the description of *laticollis* it differs in having the prothorax no wider than in *pilosa*, the smaller elytral punctures not more strongly impressed than the smaller ones of that species, the size is smaller, colour darker, and clothing different. In general appearance it is like a small dark *verreauxi*, but its flabellum has one more joint than in that species. It is the first true species of the genus to be recorded from Western Australia.

RHOPAEA DECIPIENS, n. sp.

Pl. xxv., fig. 21; pl. xxvi., fig. 48.

♂. Of a uniform and rather pale castaneous, some marginal parts and the tibial teeth darker. Clothed with fine, depressed, pale pubescence, some longer hairs scattered about on elytra, and becoming dense on parts of head and prothorax; sterna densely pilose.

Head strongly convex and with crowded punctures between eyes, becoming much larger and sparser on clypeus. Antennae ten-, flabellum six-jointed. Apical joint of maxillary palpi long, and with a narrow opaque furrow. *Prothorax* moderately long (5·5-7·5 mm.), sides strongly rounded and obtusely serrated, hind angles obtuse but not rounded off, base lightly bisinuate; median line short and feeble; punctures crowded but sharply defined. *Scutellum* with crowded punctures. *Elytra* with dense punctures of two kinds: small, shallow, and often transversely confluent ones, and considerably larger and deeper ones. *Pygidium* shagreened and with dense punctures. Front *tibiae* strongly tridentate, the second tooth slightly nearer the first than third. Length, 20-23 mm.

Hab.—New South Wales: Forest Reefs (A. M. Lea). Type, I. 4535.

On one of the specimens the sides of the prothorax and the pygidium are infuscated, but this appears to have been caused by partial decomposition. There is a dense fringe

of hairs, similar to those on the sterna, overlapping the base of the scutellum. The flabellum at first glance appears to be but five-jointed, as the produced part of its basal joint is much shorter than that of the following one, and from some directions is concealed. To the naked eye the elytra appear to have vague remnants of discal costae, but these disappear under a lens. One of the specimens before me bears Blackburn's name label "*Rhopaea hirtuosa*, Blackb." and in fact it strikingly resembles that species, but it belongs to a different section of the genus, as the flabellum, including the first short one, consists of but six joints, instead of seven. Of the males of the group AAA, it is distinguished from *verreauxi* by the shorter third joint of antennae, with the produced part of the fifth longer and more acute, the apical joint of the palpi is also much narrower; *mussoni* has the ramus of the fifth joint considerably longer and wider, and the palpi different; *rugulosa* has the upper-surface almost glabrous; from the description of *dubitans* it differs by the sides of the prothorax not being angular in the middle; by the table the third joint not "considerably longer than wide" should distinguish it from *consanguinea*.

Paralepidiota cavifrons, n. sp.

Pl. xxvi., fig. 50.

♂. Pale flavo-castaneous, elytra and antennae paler, tibial teeth blackish. Head, prothorax, and scutellum with snowy-white, rounded or elliptic, depressed scales, becoming thinner and more or less setiform on elytra, abdomen, and parts of legs; sterna and parts of legs with dense, whitish hair.

Head strongly convex, and with rather large and dense punctures, becoming smaller and sparser in middle of base. Clypeus bilobed, margins strongly elevated. Antennae ten-, flabellum seven-jointed, first joint of the latter about one-fifth shorter than the others. Apical joint of maxillary palpi wide, with a wide shallow median depression. *Prothorax* strongly convex, sides widely rounded and finely serrated, all angles obtuse; punctures sparser than on head, and much sparser about middle. *Elytra* slightly dilated to beyond the middle, apices obliquely truncated; punctures fairly dense and moderately large, becoming smaller and sparser in parts, discal costae lightly defined. *Pygidium* rather strongly margined, apex feebly bilobed; punctures rather numerous. Front *tibiae* strongly tridentate, hind tibiae with unequal spurs at apex, the larger one dilated to beyond the middle, and then narrowed to apex. Length, 20-21 mm.

Hab.—Queensland: Chillagoe (J. S. Clark). Type, I. 10783.

Smaller and duller than *lepidoptera* and with two more joints to the flabellum. The white scales are fairly dense, but nowhere overlapping on parts of the head and prothorax, and many of them do not arise above their containing punctures. There is a dense fringe of long pale hairs over the base of the scutellum. The sides of the clypeus are strongly but not suddenly elevated, leaving a flat portion a little more than one-third of the median width, and about two-thirds of the length, the flat part with larger but sparser punctures than on the sloping ones.

LEPIDIOTA FROGGATTI, Macl.

Pl. xxvi., fig. 51.

Large specimens of this species are larger (up to 42 mm.) than any other specimens I have seen of the allied genera, such specimens have the femora and tibiae entirely black, and the hind femora have the setiferous punctures nowhere dense, and there is a comparatively wide space (about the median third) from which they are quite absent. The whole of the upper-surface is densely covered with short depressed setae, and there is a fringe of long hairs at the apex of the prothorax. Some specimens from the Coen River are smaller (29-34 mm.), clothing of the upper-surface somewhat sparser (not altogether due to abrasion), hairs of the metasternum of a rusty red, and with the antennae, palpi, and legs (tibial teeth excepted), more or less reddish; the setiferous punctures of the hind femora are more numerous but not dense.

var. STRADBROKENSIS, n. var.

Pl. xxvi., fig. 52.

A specimen from Stradbroke Island (taken by Mr. Hacker in October, 1911) in the Queensland Museum, probably represents a variety of the species; it is much smaller (26 mm.), no part (except the tibial teeth) is quite black, and the hind femora are densely covered with setiferous punctures, and their lower edge is finely serrated; the preapical callosities of the elytra are rather more pronounced; there is also no fringe of long hairs at the apex of the prothorax, and this is certainly not due to abrasion, as the clothing is in perfect order.

SYSTELLOPUS ATER, n. sp.

Pl. xxvi., fig. 53.

Black and shining. Under-surface and legs with black or blackish hairs.

Head convex and almost impunctate at base, flat and with crowded punctures elsewhere. Clypeus semicircular in

front, with margins lightly upturned; hind suture conspicuous, outcurved in front, incurved at sides. Labrum on the same plane as clypeus and rather more strongly upcurved in front; with an irregular row of strong punctures in front. *Prothorax* strongly convex, sides strongly rounded, hind angles widely rounded off; along middle and across a fairly wide space near base impunctate, elsewhere with rather small but sharply-defined punctures, irregularly distributed and nowhere crowded. *Scutellum* semicircular, with rather numerous punctures. *Elytra* with shoulders, sides, and apex rounded; sutural stria distinct, with several feeble geminate striae; much of the surface finely wrinkled, and with small scattered punctures. *Pygidium* impunctate along middle, finely asperate elsewhere. *Legs* short and thick; front tibiae strongly bidentate, hind pair about as long as the apical width. Length, 25 mm.

Hab.—Australia (J. S. Clark). Type (unique), I. 10791.

The species has the robust build of many female Dynastides, to which subfamily at first glance it appears to belong; but the clypeus, labrum, tibiae, etc., are in exact agreement with *Systellopus obtusus;* from which it differs in its high polish and much greater size, characters which also distinguish it from the description of *validus*. Both antennae and five of the tarsi have been broken, but the species is so distinct that I have not hesitated to describe the type. It was sent by Mr. Clark as from Chillagoe in Queensland, but as he had an accident with a box and some labels were mixed, the locality may be doubtful, and the specimen may have really been taken in Western Australia.

Haplonycha marginipennis, n. sp.

Pl. xxvi., fig. 54.

Dark castaneous-brown with an opalescent gloss; head and parts of legs black. Head with fairly numerous long hairs between eyes, and very numerous on two basal joints of antennae, prothorax completely fringed with long hairs, narrowly on sides and base, widely in front; sterna densely clothed with dark hair, in parts almost sooty, pygidium sparsely clothed and with a thin marginal fringe; elytra with two fringes.

Head smooth at base, with crowded and coarse punctures elsewhere. Clypeus with sides strongly narrowed to the front, which is strongly upturned; front face with dense punctures. Antennae nine-, club three-jointed; fourth joint slightly longer than third and fifth. Penultimate joint of maxillary palpi distinctly longer than antepenultimate, and slightly longer than apical. *Prothorax* widely transverse, sides

strongly rounded, front angles produced and acute, hind ones rounded off; punctures rather small and not very dense, but becoming denser in front and on parts of base. *Scutellum* punctate on basal half. *Elytra* slightly dilated to beyond the middle; discal costae fairly well defined and bounded by geminate rows of punctures, the interstices with punctures much as on prothorax; suture briefly mucronate. *Pygidium* with dense punctures at base, small and sparse elsewhere. Front *tibiae* strongly tridentate. Length, 22 mm.

Hab.—Western Australia: Eradu (J. S. Clark). Type (unique), I. 10787.

Commencing near the base of each elytron there is a dense even fringe projecting downwards; from the base itself there is another fringe, but of longer and sparser hairs or setae mostly projecting outwards. The basal joint of the hind tarsi is fully as long as the second, but from most directions it appears to be slightly shorter. It is much the build of *solida*, of Blackburn's Group 4, whose elytra have similar double fringes, but the prothorax is rather densely clothed in front, and at the base has the long hairs characteristic of Group 2; in the table of that group it would be associated with *latebricola*, from which, as from all others of the group, it may be distinguished by its clothing.

Haplonycha suavis, n. sp.

Pl. xxvi., fig. 56.

Flavous and brightly iridescent, head, some marginal parts, and teeth of front tibiae reddish. Sterna moderately densely clothed with whitish hair.

Head smooth at extreme base, but with crowded punctures elsewhere. Clypeus widely rounded and strongly upturned in front. Antennae nine-, club three-jointed; fourth joint the length of third and slightly shorter than fifth. Penultimate joint of maxillary palpi slightly shorter than the adjacent ones. *Prothorax* widely transverse, sides strongly rounded in middle, front angles produced and not very acute, hind ones obtuse, but not rounded off; punctures very minute. *Scutellum* impunctate at apex. *Elytra* slightly dilated posteriorly; with rather small and not very dense punctures, geminate rows and discal costae ill-defined: suture not mucronate. *Pygidium* with fairly numerous punctures, except at apex. Front *tibiae* strongly bidentate; two basal joints of hind tibiae subequal. Length, 17 mm.

Hab.—Western Australia: Geraldton (J. S. Clark). Type (unique), I. 10789.

The upper-surface at first appears to be glabrous, but on the pronotum there is some very short evenly-distributed

pubescence (continued on to the base of the elytra), that is scarcely visible from above, but fairly distinct from the sides; the pygidium has somewhat larger (but still very short) pubescence, and a weak marginal fringe; the elytral fringe is long at the base but very short at the apex. The punctures on the head, although crowded, are nearly all sharply defined, they are just as dense in front of as behind the clypeal suture, but become sparser and smaller on the front of the clypeus; on the prothorax they are very indistinct, unless the surface is wet, but from some directions they appear like minute reddish dots. From the sides, in certain lights, the elytra appear to have faint vermiculate impressions, connecting two or more punctures, but sometimes traceable almost from base to apex; from most directions, however, they are invisible. There is a median remnant of a longitudinal carina on the pygidium. Between the second tooth and the base of the front tibia there is a feeble undulation, but it could not fairly be regarded as a tooth. As the penultimate joint of the palpi is slightly shorter than the antepenultimate, the species cannot be referred to Blackburn's Group 4, and failing that it can only be referred to Group 7; in the table of that group it would be associated with *testaceipennis*, from which, as from all others of the group, it is distinguished by the very fine pubescence of the pronotum; the punctures between the eyes are also very much denser and coarser than on that species. In general appearance it is like *neglecta*, or a very small specimen of *ruficeps* (of Group 1), *marginata* (of Group 3), and *griffithi* (of Group 5).

Haplonycha nigra, n. sp.

Pl. xxvi., fig. 55.

Black and shining, antennae (basal joint excepted), palpi and parts of tarsi more or less reddish. Upper-surface glabrous, except for a few hairs at sides of prothorax, and for a fringe of long hairs at sides of elytra; under-surface with long rusty-red hair, dense on sterna, sparser elsewhere.

Head smooth at base; with crowded punctures elsewhere but becoming sparser and sharply defined towards apex of clypeus. Clypeus with rather strongly elevated margins. Antennae nine-, club three-jointed; fourth joint slightly longer than the adjacent ones. Penultimate joint of maxillary palpi slightly longer than the antepenultimate, but distinctly shorter than the apical one. *Prothorax* widely transverse, sides strongly rounded, front angles strongly produced and acute, hind ones rounded off; with dense and fairly large sharply defined punctures, becoming crowded in places. *Elytra* slightly dilated to beyond the middle, suture not

mucronate; punctures fairly large and dense, becoming crowded posteriorly, geminate rows and discal costae well defined. *Pygidium* with dense subasperate punctures, becoming crowded in corners, and sparse at apex. Front *tibiae* strongly tridentate; basal joint of hind tarsi longer than second. Length, 18·5 mm.

Hab.—Western Australia: Kuminin (E. F. du Boulay). Type (unique), I. 10793.

The punctures between the eyes are so crowded that part of the surface has a vermiculate appearance; the clypeus from behind appears to be truncated in front, but from directly above it is seen to be gently rounded. The penultimate joint of the palpi from some directions appears slightly longer, but from others no longer than the antepenultimate, hence, as the pronotum and pygidium are black, there need be no hesitation in referring this species to Blackburn's Group 8; from the species of that group he somewhat doubtfully identified as *gagatina*, Burm., it differs in being much larger, prothorax shining, with strong well-defined punctures, and the pygidium also with stronger punctures; from *funerea* it differs in the much coarser punctures of the entire upper-surface and pygidium, and the elytra without a conspicuous margining membrane; they have, however, an extremely short fringe projecting downwards that could be easily overlooked.

Glossocheilifer bidentatus, n. sp.

Pl. xxvi., figs. 57 and 58.

Reddish-castaneous; club of antennae and elytra flavous, suture base and margins of the latter darker. Upper-surface glabrous, except for a few long hairs in latteral gutters of prothorax; elytra with a short dense fringe of golden setae projecting downwards, and with a straggling fringe of long reddish hairs projecting outwards; sterna with dense whitish hair, rest of under-surface more sparsely clothed, the hairs darker, stiffer, and many arising from minute granules.

Head with fairly dense and not very large, but sharply defined punctures, coarser on basal half of clypeus than elsewhere. Clypeus gently rounded in front, margins moderately upturned. Labrum conspicuously produced and upturned in front. Antennae nine-, club three-jointed. Penultimate joint of maxillary palpi shorter than the adjacent ones. *Prothorax* strongly transverse, sides strongly rounded, front angles produced and acute, hind ones completely rounded off; punctures small and not very dense. *Elytra* slightly dilated to beyond the middle; punctures not very dense or large but sharply defined, geminate rows and discal costae feeble; suture not produced at apex. *Pygidium* strongly convex, punctures

dense in places, not very large but more or less asperate. Front *tibiae* very strongly and acutely bidentate; basal joint of hind tarsi slightly shorter than second. Length 16-19 mm.

Hab.—Western Australia; Swan River and Geraldton (J. S. Clark). Type, I. 10790.

On the Swan River specimen, the larger of the two under examination, there are tufts on the front tarsal joints, probably indicating that it is a male; the shape of the labrum of the Geraldton specimen is not exactly the same as on the other, but it has the appearance as of being slightly malformed. At first glance the species appears to be quite an ordinary *Haplonycha*, like *testaceipennis*, *jungi*, *gracilis*, etc.; but with the produced labrum considered by Blackburn as sufficient to found the genus *Glossocheilifer;* its bidentate front tibiae readily distinguish it from *addendus* and *labialis;* in appearance it is fairly close to the former. Disregarding the labrum and associating it with *Haplonycha*, it would be referred to Group 6 or 7, probably the former.

Glossocheilifer addendus, Blackb.

Recorded by Blackburn as probably from Western Australia. Mr. J. S. Clark has taken specimens at Geraldton, and both of us from near the Swan River.

Stethaspis squamosus, n. sp.

Pl. xxvi., figs. 59 and 60.

Coppery-green or coppery-purple, elytra, antennae, palpi, and legs more or less reddish. Irregularly clothed with white scales; tip of pygidium and part of under-surface and of legs with long white hairs.

Head rather wide, rather lightly convex, with not very numerous but sharply-defined punctures of moderate size. Clypeus with hind suture strongly triangularly produced backwards, middle strongly convex, margins moderately elevated, front truncate; punctures denser and larger than on rest of head. Antennae nine-, club four-jointed and rather small, second joint almost as long as three following combined, fifth acutely produced on one side. *Prothorax* apparently twice as wide as long, sides finely margined, subparallel on basal half, thence oblique to apex, base with a conspicuous median lobe, the hind angles almost rectangular, apex gently arcuate, the front angles subarcuate, with an obtuse impunctate median line on basal half, elsewhere with punctures slightly smaller and usually sparser than between eyes. *Elytra* gently dilated to beyond the middle, apex widely truncate; each with fourteen deep striae, containing rather small

punctures; interstices regular, strongly convex and impunctate; a fine marginal membrane not extending to base. *Pygidium* and propygidium with small, dense, sublaminate punctures. *Mesosternum* with a strong process produced to front of front coxae, flat on lower-surface, arcuate above, and truncate at apex. *Legs* rather short, front tibiae strongly bidentate. Length, 14-16 mm.

Hab.—Queensland: Cairns district (F. P. Dodd, H. H. D. Griffith, and A. M. Lea). Type, I. 4840.

One specimen bears a note by the late Rev. T. Blackburn, "Not *Xylonychus*, probably female of gen. nov. very near *Colymbomorpha*," but as there appear to be only females of the species before me, I think it desirable to refer them to *Stethaspis* (=*Xylonychus*), from all the species of which they may be distinguished by the dense scales at the sides of the under-surface; the intercoxal process of the mesosternum is more produced than in *eucalypti*, being almost as in *Phyllocerus purpurascens*. The elytra have a slight metallic gloss, but their margins are conspicuously metallic. The scales are wide, and conspicuously dense, white, and overlapping at the sides of the under-surface, and on the middle of the propygidium, they are almost as dense on the sides of the pronotum, but individually narrower; on the rest of the upper-surface they are sparser and subsetose in character; on the elytra they are confined to the striae, on the pygidium and the rest of the propygidium they are fairly dense; there are usually three long hairs on each side of the prothorax. On the type there are seven punctures on the scutellum, but on the other specimens they are more numerous.

In a recent letter Mr. G. J. Arrow remarked, "It seems to me quite unnecessary to make a new genus for *S. squamosus*: we have four specimens of it, from Kuranda; they include both sexes, but the antennae of the male scarcely differ from those of the female."

Colymbomorpha splendida, n. sp.

♂. Brilliant purplish-green with a coppery gloss; front of head, sides of prothorax, propygidium, pygidium, under-surface, and legs (hind tibiae and parts of tarsi excepted) flavous, with a coppery-green gloss. Upper-surface glabrous, under-surface almost so.

Head with sparse and small, but sharply-defined punctures. Clypeus about twice as wide as long, front truncated, disc rather strongly convex; punctures at apex and sides denser and stronger than between eyes. Labrum on the same plane as clypeus, narrow, apex gently incurved. Antennae nine-, flabellum six-jointed, the rami each about as long as

the clypeus is wide. *Prothorax* not twice as wide as long, base much wider than apex, front angles produced and almost equilaterally triangular; hind ones strongly produced, sharply angular and slightly embracing shoulders, base strongly bisinuate; punctures sparse and minute, becoming larger, although still sparse, on sides. *Scutellum* highly polished and impunctate. *Elytra* each obliquely truncated at apex, outlines continuous with those of prothorax; with rather strong, regular striae, containing shallow punctures, but these becoming more distinct towards base; interstices impunctate. *Metasternum* and hind coxae with rather large sparse punctures; intercoxal process of mesosternum obtuse and vertical in front. Front *tibiae* tridentate, apical tooth acute and moderately long, second small but acute, third very feeble. Length (♂, ♀), 9-11 mm.

♀. Differs in being slightly wider, abdomen more convex, legs shorter, antennal rami much shorter, and the fourth joint without one, so that the flabellum consists of but five joints, and the hind tibiae not entirely dark.

Hab.—New South Wales: Dorrigo (W. Heron and H. J. Carter from R. J. Tillyard). Type, I. 4851.

Differs from *lineata* in colour, in the polished and glabrous surface (the only clothing consists of a few stiff bristles on parts of the under-surface and legs) in the clypeus, etc.; the intercoxal process of the mesosternum is strong and well produced, but its front face is thick and rounded off; in *lineata* it is produced to an almost knife-like edge between the front coxae. In *Phyllococerus purpurascens*, which Blackburn considered[8] should be referred to *Colymbomorpha*, the intercoxal process is not produced with a knife-like edge between the front coxae, but as a truncated process above them. In *C. lineata* the front of the clypeus is evenly rounded and conspicuously upturned, so that, when viewed from behind, the labrum is almost concealed, but on the present species it appears to be attached to the clypeus as in the Systellopides. By the characters noted by Blackburn,[9] in dividing the Melolonthides into subtribes, this species would be referred to the Systellopides, in this agreeing with *Phyllotocus*, although both genera differ in many particulars from the members of that anomalous group.

Sericesthis suturalis, Macl., formerly Scitala.
Scitala pruinosella, Brenske.

Blackburn (who also associated it with *pruinosella*) has commented upon the bad condition of the type of *suturalis* (it

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[8] Trans. Roy. Soc. S. Austr., 1911, p. 175.
[9] *L.c.*, 1905, p. 276.

has lost five of its tarsi, both antennae, and all the palpi); but there is a specimen of the species in the South Australian Museum from Mackay, it has nine-jointed antennae, but the fifth and sixth joints are so thin and closely applied to the three-jointed club that it is difficult to see them clearly, the rami of the club are about the combined length of the two apical joints of the palpi, the basal joint of the hind tarsi is not much, but distinctly, longer than the second.

Phyllotocus ruficollis, Macl.

P. sericeus, Macl.

There are three specimens in the Australian Museum standing as types of *sericeus*, and all are of the species tabled by Blackburn[10] as *ruficollis*, although he was dubious as to his identification of that species; the type of *ruficollis* was badly stained, but was partially cleaned for description. It is certainly not the species Blackburn identified and tabled as *australis*,[11] and which he thought might be *sericeus*.

Phyllotocus variicollis, Macl.

Correctly identified and tabled by Blackburn.[12]

Phyllotocus bimaculatus, Er.

On the typical form of this species each elytron has a pale, completely-enclosed spot of variable size, on the basal half; on Tasmanian specimens the spots are usually smaller than on mainland ones.

var. nigripennis, n. var.

Mr. H. J. Carter and I recently obtained at Strahan (Tasmania) numerous specimens that differ from the typical form in having the elytra entirely black; the paler parts are also of a brighter red.

var. basalis, n. var.

Mr. Aug. Simson obtained at Wentworth Falls (New South Wales), in company with typical specimens, numerous others in which two-fifths of the base of the elytra are pale, the dark part is usually, but not always, advanced along the suture to the base.

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(10) Trans. Roy. Soc. S. Austr., 1898, p. 24.

(11) *L.c.*, p. 23.

(12) *L.c.*, pp. 23 and 24.

var. INSULARIS, n. var.

Mr. H. Hacker obtained on Bribie Island (Queensland) three specimens that are more highly polished than usual, they have only the apical two-fifths of the elytra infuscated (and not very deeply so) and a slight infuscation about the scutellum; they are also smaller (5·5-6 mm.) than the typical form.

PHYLLOTOCUS MACLEAYI, Fisch.

This species occurs in abundance on eucalyptus and other blossoms in New South Wales, Victoria, and Tasmania.

var. ASSIMILIS, Macl.

This was considered by Blackburn as a variety only of *macleayi*, and such is my own opinion.

var. PALLIDUS, n. var.

Six specimens taken between Karoonda and Peebinga (by Mr. G. E. H. Wright), one from Murray Bridge (by Mr. H. H. D. Griffith), and one from Lyndoch (by Mr. J. G. O. Tepper), differ from the typical form in being entirely pale.

PHYLLOTOCUS LURIDUS, Macl. (formerly CHEIRAGRA).

As the claws to the four hind legs of this species are long, thin, and simple the species by Blackburn's generic table of the Sericides must be referred to *Phyllotocus*. Although Macleay said "The male and female differ very little," both specimens (presumably the types) standing under the name in the Macleay Museum are males, each having three long antennal rami. The species occurs in Queensland (Mapleton and Blackall Range) as well as in New South Wales, and all those before me are more or less brightly iridescent, the elytra are flavous with the suture, and a variable amount on each side infuscated or black, each of the hind femora has a wide tooth or subtriangular flange at the middle.

PHYLLOTOCUS OCCIDENTALIS, Blackb.

This species occurs in South Australia (Karoonda to Peebinga) as well as in Western Australia; in commenting upon the types Blackburn remarked that the apices of the elytra were "almost devoid of fuscous shading"; some of the specimens in the museum are entirely devoid of it; such specimens may be readily distinguished from the variety *pallidus*, of *macleayi*, by the completely rounded off hind angles of the prothorax, and by the bidentate, instead of tridentate, front tibiae.

var. APICIFUSCUS, n. var.

Two specimens from Karoonda to Peebinga (G. E. H. Wright), and one from Mindarie (South Australia), have the apical fourth of the elytra deeply infuscated (almost black), they may be readily distinguished from the typical form of *macleayi* by the basal angles of prothorax and by the front tibiae.

PHYLLOTOCUS, sp.

An entirely pale specimen (from Edithburgh in the Blackburn collection) combines characters of two species, as the hind angles of the prothorax are rectangular as in *macleayi*, and the front tibiae bidentate as in *occidentalis*.

PHYLLOTOCUS MARGINATUS, Macl.

Specimens of this species taken on Stradbroke Island (Queensland) by Mr. Hacker are smaller (5 mm.), than usual, with part of the apex of the elytra black, and the pale marking on the sides of the prothorax of the female smaller than usual.

PHYLLOTOCUS AUSTRALIS, Boi.

Specimens of this species taken on Stradbroke Island by Mr. H. Hacker, and at Cairns by Mr. F. P. Dodd, are smaller (5·75 mm.) than usual, and with the pronotum, scutellum, and elytra (except for a slight infuscation of the latero-apical margins of the latter) entirely pale.

PHYLLOTOCUS USTULATUS, Blanch.

The prothorax of this common Western Australian species varies from entirely black (as on the type) to entirely reddish; several specimens before me have the prothorax reddish, with three infuscated spots: a moderately long median one and a small one towards each side.

PHYLLOTOCUS NAVICULARIS, Blanch.

In his table of the species of this genus Blackburn placed *navicularis* in the first section "A. Elytra glabrous (or nearly so) except along their lateral margin." But on many specimens before me the hairs are quite as numerous about the suture and base as on specimens of species he referred to "AA. Elytra clothed with hairs (at any rate along the suture and base)."

The typical form has the head, prothorax, and a large spot on each elytron black, the spots frequently have a greenish or bluish iridescence, on the sides they occupy about half the length; along the suture they are conjoined for about half their own length, being divided in front by a

sutural extension of the reddish basal portion. The species is common in parts of Queensland and of northern New South Wales; in addition to the varieties noted below there are others in the Museum.

var. RUFIBASIS, n. var.

Four specimens from Cape York (H. Elgner), differ from the typical form in having only about one-fourth of the elytra reddish, the black being widely subtriangularly advanced in front, so that it almost extends to the scutellum.

var. ERYTHRODERES, n. var.

Three specimens from the Coen River (W. D. Dodd), differ in having the prothorax entirely reddish; on two of them the apical half of the elytra is dark, but the suture is pale for portion of the distance; on the third specimen the spots are as on the typical form.

var. APICALIS, Macl.

Three specimens from the Coen and Stewart Rivers (W. D. Dodd), and Cairns (E. Allen), differ in having the prothorax and four basal segments of abdomen reddish, but elytra with the apical markings typical; this form appears to be the one described from Port Denison by Macleay as *apicalis*. Three other specimens from Cape York (H. Elgner) agree with these, except that the black portion is advanced to cover slightly more than half of the elytra.

PHYLLOTOCUS LATEROFUSCUS, n. sp.

Flavous; an infuscate vitta occupying about one-third the length of each elytron near the side, abdomen slightly darker than metasternum. Glabrous except for a few stiff setae on sides of prothorax and of elytra, and on the legs.

Head flattened, and with scarcely visible punctures. Clypeus not distinctly separated from labrum in middle, their combined length about two-thirds of the basal width. Antennae nine-, club three-jointed, the lamellae rather short. *Prothorax* about once and one-half as wide as long, sides rather strongly rounded, front angles produced and acute, hind ones rounded off; punctures fairly dense, but small and inconspicuous. *Elytra* with rows of fairly large punctures in conspicuous striae, interstices gently convex, and of almost even widths, except that they become narrower towards the sides. Hind *coxae* at sides much longer than metasternum; front tibiae bidentate; front claws uneven, the larger one moderately thick, but not appendiculate. Length, 5·5 mm.

Hab.—Queensland: Endeavour River (Dr. A. R. Pulleine, and National Museum from C. French). Type, I. 10775.

In Blackburn's table of the genus this species would be placed beside *occidentalis*, from which it differs in the elytra being more strongly striated, with larger punctures in the striae, and by the dark lateral markings; it is not very close to any other species before me. The elytral vittae are rather narrow, and are quite distinct, but their outlines are not sharply defined. The clypeus in front is slightly upturned on each side, but not in the middle, the uplifted parts being almost concealed by the rather strongly elevated labrum, which appears to be pressed close to them. The upper-surface is only slightly polished, but it could hardly be called opaque. The abdomen is small and curved to the tip, so the specimens are probably males, despite the non-appendiculate front tarsi.

Phyllotocus basicollis, n. sp.

♀. Head and metasternum reddish-brown, prothorax and scutellum reddish-flavous, elytra black and brightly iridescent, but margins (except at base) pale, abdomen and club of antennae black, legs flavous, the hind tibiae infuscated at apex. Front and sides of prothorax, sides and apex of elytra and pygidium with flavous or reddish setae.

Head with small and crowded but distinct punctures. Clypeus not quite the length of an eye, and more than thrice as wide as long; labrum slightly more than half the length of clypeus, its margins lightly upcurved and the front one gently incurved to middle. Antennae nine-, club three-jointed. *Prothorax* not much wider than the greatest length, basal half parallel-sided, front and hind angles produced and acute, the latter embracing shoulders; without punctures except for those containing the margining setae. *Elytra* with well-defined striae containing shallow punctures; interstices gently convex, moderately wide near suture, narrower towards the sides. *Abdomen* strongly convex, each of four segments with a conspicuous row of setiferous punctures. Hind *coxae* at sides almost twice the length of metasternum, and with sharply-defined but not very dense punctures; front tibiae tridentate; front claws equal and simple. Length, 5-5·5 mm.

Hab.—Queensland: Brisbane, November, 1912, and November, 1916 (H. Hacker). Type, in Queensland Museum; cotype, I. 10777, in South Australian Museum.

The hind angles of the prothorax embracing the shoulders are without parallel in the genus; the claws are all thin, simple, and long, but not of the great length that is usual in *Phyllotocus*, and in other respects it is not close to any

other before me. The comparatively large, evenly-convex abdomen, with simple front claws, are indicative that the specimens taken by Mr. Hacker are females; one of them has beautiful golden depressed pubescence margining the base of the prothorax, of the elytra and scutellum, and forming a patch on each side of the pygidium; it is absent from the other, probably due to abrasion. The elytral striae are almost absent posteriorly and about the shoulders.

Phyllotocus decipiens, n. sp.

♂. Black; elytra with two conspicuous flavous vittae. Sides of prothorax and of elytra fringed with dark setae.

Head gently convex and with small punctures between eyes. Clypeus about thrice as wide as the median length; punctures denser and coarser than between eyes, sides moderately elevated, front not elevated in middle; labrum short, distinctly separated from clypeus, moderately upturned in front. Antennae eight-, club three-jointed. *Prothorax* scarcely one-fourth wider than long, sides gently rounded, front angles produced and acute, the hind ones almost rectangular; punctures as between eyes. *Elytra* with well-defined but not even striae, mostly containing distinct but not very large punctures; interstices gently convex, narrower towards sides than towards suture, with small but fairly distinct punctures. Hind *coxae* at sides scarcely one-fourth longer than metasternum; front tibiae tridentate; front claws unequal. Length (♂, ♀), 5-6·5 mm.

♀. Differs in having the club of the antennae somewhat smaller, abdomen larger, legs shorter, and front claws even.

Hab.—Victoria: Melbourne, eating grass, in October, 1911 (C. French, sen.), Oakleigh (C. French, jun.); South Australia: (F. Secker); Tasmania (Simson's collection). Type, I. 10839.

In general appearance strikingly like *meyricki*, from Western Australia, with which I had it confused, but the front part of the head is very different; on that species the clypeus and labrum are soldered together without a conspicuous suture, the front strongly upcurved, and a wide and feebly-punctate elevation occupying most of the base; on the present species the suture between the clypeus and labrum is well defined, the labrum is shorter, wider, and less elevated in front, and the subtubercular elevation of the clypeus is lower (although quite as wide) and with more conspicuous punctures. In Blackburn's table of the genus it would also be distinguished from *meyricki* by the tridentate, instead of bidentate, front tibiae; in that table it would be associated with *macleayi*, which is a larger and very differently-coloured

species with head and legs different. The dark part of the elytral suture is wide and almost parallel-sided, but from each side the dark part is absent, or almost so, at the shoulder, and gradually dilates till near the apex it curves round to join in with the sutural part; the claws and parts of the tibiae, sometimes also other parts of the legs, are more or less reddish. Parts of the upper-surface and of the sterna have a pruinose bloom. From above the basal angles of the prothorax appear to be quite right angles, but from the sides they are seen to be slightly obtuse; most of the specimens have a vague median line. The front claws of the male are of even length, but the larger one increases much in thickness to the base, although it is not appendiculate.

Phyllotocus cribriceps, n. sp.

♂. Black, elytra usually with some parts paler, and with a bright bluish iridescence; front legs mostly flavous, parts of the other legs obscurely diluted with red. Prothorax and elytra fringed with long and mostly pale setae, a few on head and many on under-surface and legs.

Head with dense, sharply defined, and rather small punctures. Clypeus obliquely flattened, sides slightly elevated; punctures as between eyes; hind suture distinct only at sides, the front one throughout; labrum short, sharply defined, rounded and gently elevated in front. Antennae eight-, club three-jointed. *Prothorax* about once and one-half as wide as long, sides evenly rounded, apex evenly incurved with the front angles acute but scarcely separately produced, hind ones rounded off; punctures sharply defined, about as large as on head but not so dense. *Elytra* with strong striae containing rather large punctures, except posteriorly; interstices rather strongly convex, narrower towards sides than suture. Hind *coxae* at sides scarcely longer than metasternum, and both with distinct punctures; all femora stout, the hind ones especially so; hind tibiae shorter and stouter than usual, the front ones tridentate; front claws unequal, the larger one scarcely longer than the other, but more strongly curved, and with a large basal appendix. Length, 4·5-5 mm.

Hab.—Queensland: Mapleton, in October. Type, in Queensland Museum; cotype, I. 10837, in South Australian Museum.

As the antennal lamellae are long, the abdomen curved to its tip, and the front claws unequal, on each of the eight specimens from Mapleton, they are evidently all males. In general appearance the species is close to *luridus*, but is smaller, narrower, hind femora unarmed, and a smaller

amount of elytra pale. The basal half of the elytra (except the suture and margins) is more or less obscurely flavous or reddish, but the markings, although usually distinct to the naked eye, are not sharply defined; one specimen has the elytra, except for their brilliant iridescence, entirely black. The front of the head seems slightly concave, owing to the obliquely flattened clypeus, with its edges and the front of the labrum elevated: the cephalic punctures, although small, are decidedly larger than usual in the genus. Each of the antennal lamellae is almost as long as the five basal joints combined, the fifth joint is very short, and can scarcely be seen except under a compound power.

Phyllotocus antennalis, n. sp.

♂. Flavo-testaceous, some parts more or less deeply infuscated. Prothorax and elytra fringed with white or brownish hairs; similar hairs on under-surface and legs.

Head with dense and sharply-defined, but not large punctures. Clypeus about four times as wide as long, sutures well defined, punctures as between eyes; labrum about half the length of clypeus, apex gently curved and moderately uplifted. Antennae nine-, club five-jointed, each lamella as long as the four basal joints combined. *Prothorax* about once and two-thirds as wide as long, sides moderately rounded, front rather strongly incurved to middle, front angles acute, the hind ones rounded off; punctures not very dense, and small but sharply defined. *Elytra* comparatively short; striae strong and containing well-defined punctures, interstices gently convex and with minute punctures. Sides of hind *coxae* slightly longer than metasternum; hind femora stout and edentate; front tibiae acutely tridentate; front claws unequal, the larger one with a large isosceles-triangle-like basal appendix. Length, 5-5·25 mm.

Hab.—New South Wales: Dorrigo (W. Heron). Type, I. 4279.

The three specimens taken by Mr. Heron are males, and as the middle claws are without long quill-like appendages, the species cannot be referred to *Phyllotocidium*, to which at first it appears to belong. The front of the head is much as in a female cotype of *Phyllotocidium macleayi* and so much more abrupt than in *Phyllotocus*; the antennal club composed of five joints is also greatly aberrant, but Blackburn has frequently commented on the fact that the number of joints composing the antennae or the club in Australian Melolonthides, cannot be relied upon generically; the third joint of the antennae is of considerable length, but the fourth is so small and closely applied to the club that it cannot be

distinguished from most directions. Seen from behind the greater portion of the head appears gently concave, owing to the flattening of the middle parts and the slight elevation of the sides of clypeus and front of labrum. The elytral striae and punctures are confused about the tips, but regular elsewhere. The three are (except for slight variations) similarly coloured, so presumably are not immature; the head is more deeply infuscated than other parts, some of its margins being blackish, the antennal club is also blackish; the scutellum, suture, and sides of elytra, parts of sterna (sometimes the whole under-surface), and parts of legs are more or less deeply infuscated, and there are two large but vague discal blotches on the prothorax.

Cheirrhamphica.

Blackburn proposed this genus for species possessing the enormous front claws of the males of *Cheiragra*, but with the others long and simple; in his table it was distinguished by "basal four joints of front tarsi together shorter than apical process of tibia," but this holds good only for the male; in the female the joints of the front tarsi are longer and much thinner, the fourth conspicuously passes the tibiae, and the fifth is smaller with uniform claws.

Cheirrhamphica pubescens, Blackb.

The common form of the male was the one described by Blackburn, but the female is usually larger, and varies from a form having the upper-surface entirely dark to one in which it is entirely pale. The front tibial teeth are two in number, acute and fairly long, characters sufficient to distinguish the species from all the known Queensland members of the genus. It may be taken in abundance, from flowering wattles, from Geraldton to Beverley in Western Australia.

Cheirrhamphica insularis, n. sp.

Black; front femora and tibiae, and antennae, except club, flavous. Upper-surface with numerous more or less upright pale hairs or setae, parts of under-surface and of legs with somewhat longer ones.

Head smooth and with minute punctures about base, and crowded, with some larger ones between eyes. Clypeus semicircular, with crowded punctures, its sides gently upturned; labrum appearing as an upturned front margin to the clypeus. Antennae eight-, club three-jointed, lamellae scarcely longer than apical joint of palpi. *Prothorax* scarcely one-fourth wider than its greatest length, sides evenly rounded, front angles produced and acute, the hind ones gently rounded off; punctures fairly dense and sharply defined. *Scutellum* with

a few basal punctures. *Elytra* rather narrow, basal half about the width of prothorax, thence strongly narrowed to apex, where each is almost pointed; with rows of rather large, asperate punctures, in shallow striae; odd interstices very feebly, in places not at all, elevated above the even ones. *Abdomen* small, curved to tip. Sides of hind *coxae* much longer than metasternum; hind femora and tibiae stout; front tibiae unidentate; front claws unequal, the others very long and thin. Length, 5-5·5 mm.

Hab.—Queensland: Stradbroke Island (H. Hacker and Dr. A. J. Turner). Type, I. 10776.

The specimens from the island are evidently of one sex, and are probably males, as the front tarsi are moderately thick (thinner than in males of *pubescens*, *coralis*, and *tuberculata*) and passing the tips of the tibiae, but decidedly thicker than in the females of *pubescens* and *tuberculata*, and the front claws are decidedly uneven, one being quite small, and the other much larger, although much smaller than in known males of the genus, its abdomen also curves to the point as in undoubted males. If they are males the specimens before me are certainly distinct from *interstitialis*, described as from Northern Queensland; I examined the type of that species prior to its being sent to the British Museum, and noted that it was a peculiar-looking insect with somewhat similar colour and clothing to the present one, but opaque, the prothoracic punctures less conspicuous, and the head longer, with much smaller punctures; the specimens differ from the description also in having the elytra rugose, and without four obsolete costae, so that even if females they are unlikely to belong to that sex of *interstitialis*. The upper-surface is shining, but that is not always a feminine character in the allied genera. On two specimens the middle tibiae and parts of the hind legs are partly pale, but obscurely so. The tooth of each front tibia, including the curve at its commencing point, is fully half the length of the tibia itself: the claws of the middle tarsi are slightly uneven and one is slightly less curved than the other. The larger punctures between the eyes are about as large as the ones on the prothorax. On some of the specimens the clothing on the upper-surface is almost upright, on others it slopes at about 45°, the difference being probably due to treatment after capture.

CHEIRRHAMPHICA COXALIS, n. sp.

♂. Flavous, some parts deeply infuscated or black. Upper-surface more or less opaque and with a pruinose gloss, more pronounced on the elytra than elsewhere. Clothing much as on preceding species, except that on the disk of the elytra it is somewhat shorter.

Head with very small punctures at base, dense and of moderate size between eyes. Clypeus semicircular, front margin gently upturned throughout, punctures as between eyes; labrum closely applied to clypeus. *Prothorax* moderately transverse, sides evenly rounded, front angles produced and acute, the hind ones moderately rounded off; punctures fairly numerous. *Elytra* with outlines and punctures much as on preceding species, except that the punctures are somewhat smaller. *Abdomen* small, curved to its tip. Hind *coxae* very large, their sides fully twice the length of the metasternum; hind femora and tibiae stout; front tibiae unidentate; front tarsi stout, fourth joint not passing tibiae, claw joint stout, claws very unequal, other claws very long and thin. Length, 5-5·25 mm.

Hab.—Queensland: Cairns (E. Allen). Type, I. 4290.

Distinguished from the preceding species by the less rugose elytra and absence of larger inter-ocular punctures, in addition to the very different colour and claws: the five specimens taken by Mr. Allen are all males, they differ from the description of *interstitialis* in colour and by the sculpture of the prothorax and elytra. The hind coxae seem to project almost as the drums of many species of cicadas: the longer claw of the front tarsus is almost as long as those of the others, but is irregularly widened towards its base, the smaller claw is scarcely half its length, and is much thinner, the middle claws although both long and thin are unequal, one being distinctly shorter, thinner, and less curved than the other. The elytra are black, or almost so, except for a transverse space on each side of the base, each space sometimes continued for a short distance near the suture, the hind tibiae are deeply and the hind tarsi and the head slightly infuscated; the abdomen is usually darker than the metasternum: the antennae are entirely pale. On one specimen the scutellum is rather dark, and there are two large smoky blotches on the prothorax. Four of the specimens have the prothorax and elytra entirely opaque, but the fifth is shining, evidently owing to abrasion, as many of its hairs are missing, its punctures in consequence are much more distinct, especially on the prothorax.

Cheirrhamphica tuberculata, n. sp.

♂. Flavous, parts of legs tinged with red, sides of elytra partly infuscated. Clothed with numerous conspicuous pale upright setae, longer on sides of prothorax and elytra than on their disks, legs and parts of under-surface with moderately long hairs.

Head with fairly dense and small punctures, but interspersed with some fairly large ones between the eyes.

Clypeus semicircular, sides moderately uplifted; punctures, except that there are no large ones, as between the eyes; labrum, except at sides, not distinctly separated from clypeus, and apparently forming its uplifted front edge. Antennae eight-, club three-jointed. *Prothorax* moderately transverse, sides evenly rounded, front angles produced and acute, the hind ones rounded off; punctures fairly numerous. *Elytra* scarcely wider than head, parallel-sided to beyond the middle and then strongly narrowed to apex, with fairly distinct punctures in shallow striae. *Abdomen* small, curved to its tip. Hind *coxae* at sides much longer than metasternum; hind femora and tibiae stout; front tibiae short, stout, and unidentate, front tarsi thick, the fourth joint not passing the tibia, claw joint stout with very uneven claws; middle and hind claws long and thin. Length (♂, ♀), 5-5·25 mm.

♀. Differs in having the prothorax more narrowed in front, and with more distinct punctures, elytra less parallel-sided, with more distinct striae and punctures, and a conspicuous elongated tubercle on the middle of each side, abdomen larger and evenly convex along middle, legs somewhat shorter, front tarsi much thinner, fourth joint passing the tibia, and the claw joint thin with small equal claws.

Hab.—Queensland: Endeavour River (C. French). Type, in National Museum; cotype, I. 10838, in South Australian Museum.

A narrow pale species with peculiar tubercles on the elytra of the female; each tubercle is elongated, about one-fifth the length of the elytron, and whilst scarcely elevated above the general convexity of the surface, is rendered very distinct by the cutting away, as it were, of the adjacent parts. On the female the prothorax is shining and its punctures are rather large and very distinct, with numerous minute ones interspersed; on the male the surface is opaque, and the larger punctures are partly obscured, the minute ones disappearing. The infuscation of the sides of the elytra is rather narrow and varies in intensity, being more pronounced on the males than on the females. On the front tarsi of the male the three median joints are all much wider than long, the larger claw is quite as large as its supporting joint, and is considerably dilated to the base, the smaller claw is less than half its length and very thin; the claws on the middle legs are both long and thin, but one is distinctly longer and thicker than the other, on the hind legs the claws are almost even.

Cheiragra.

This genus was proposed by Macleay to receive a number of small species allied to *Phyllotocus*, but with a membranous

appendage to each claw, the front claws of uneven size, and the larger one enormously developed. To it he referred *Phyllotocus pusillus*, Blanch., and six species which he supposed to be new—*ruficollis*, *pallida*, *aphodioides*, *atra*, *pygmaea*, and *lurida*, but the last-named species it is necessary to transfer to *Phyllotocus*. Subsequently he described another species, *vittatus*, referring it, however, to *Phyllotocus*. Blackburn also referred a new species, *macleayi*, to the genus, but subsequently made it the type of a new one, *Phyllotocidium*.

With long series of most species before me it seems probable that *all* the species of the genus are very variable in colour, and that perfect males have the prothorax and elytra sericeous, but that those parts are shining in the females. The females of several species may be readily distinguished *inter se* by the latero-posterior margins of the elytra being notched or flanged. By the courtesy of Mr. Shewan I have been able to examine all the specimens of the genus in the Macleay Museum.

CHEIRAGRA PUSILLA, Blanch. (not Macl.).
C. pygmaea, Macl., ♂.
C. aphodioides, Macl., ♀.

From examination of the named specimens in the Macleay Museum I am satisfied that Macleay wrongly identified *pusilla* (which presumably he regarded as the type of the genus), and that the species he named *pygmaea* is the real *pusilla*. The type was certainly a male, as its prothorax was described as "*nigro, opaco, haud punctato*" (punctures are present but could be easily overlooked).

Two specimens were labelled with a query as *pusilla*, these are 4 mm. in length, and have the prothorax entirely pale, they belong to forms 2 and 3 of *ruficollis*; three others were labelled without a query as *pusilla*, and are still larger, two are males and have the prothorax darker than the smaller ones, they belong to forms 2 and 4 of *ruficollis*: the other is a badly-damaged female close to form 7 of *ruficollis*.

Four specimens standing under the name of *aphodioides* in the Macleay Museum are all females of the real *pusilla*, not one of them has the elytra black, or even much darker than any of the others, the colour being of the same shade as the base of the prothorax; they all have conspicuous punctures on the prothorax, and the front claws not enormously developed.

The species is the smallest of the genus: in the common form of the male the head and prothorax are black and the elytra pale, but with the sides widely infuscated or black

(the infuscation occasionally extends over most of the surface); in the common form of the female (including the types of *aphodioides)* the head and prothorax are infuscated, but the base of the latter is pale, the elytra are also entirely pale. The sides of the elytra of the female are not notched or flanged, and by this feature alone it may be readily distinguished from small females of *ruficollis* and *sericeipennis.*

CHEIRAGRA RUFICOLLIS, Macl.

C. pusilla, Macl., in error.

C. pallida, Macl., ♀.

Pl. xxv., fig. 23.

The original description of this species (which appears to be confined to New South Wales and Victoria) is unsatisfactory, and of the specimens standing as *ruficollis* in the Macleay Museum, not one agrees exactly with it; of the five specimens so standing two are males and three are females. One of each sex has the elytra entirely dark (whereas the description implies that the whole upper-surface is testaceous) and the head and prothorax of a rather bright reddish-flavous; to the male I have attached a label that it is probably the type; the second male has the head and prothorax of an obscure reddish-brown, the elytra testaceous with the suture darker (much the colour of the prothorax), and the sides widely margined with black; of the other females one has the prothorax as dark as in the second male, but with all its margins and a narrow line down the middle paler, it has also an obscure pale vitta extending from the base to about the middle of each elytron; the third female has a wider and longer vitta passing the middle of each elytron, and agreeing with "The female . . . sometimes a light patch on the disc of each elytron." These specimens vary from $1\frac{1}{2}$ to 2 lines in the males, and from $2\frac{1}{4}$ to $2\frac{1}{2}$ in the females, but were described as 2 lines.

The species is the most variable of the genus, but the females may be at once distinguished by the sides of the elytra, as near the apex of each there is a conspicuous notch (pl. xxv., fig. 23); the female, as in others of the genus, also differs from the male in having the prothorax shining and with conspicuous punctures.

The specimens described by Macleay as *pusilla* belong to this species, whilst the types of *pallida* (Macleay) also belong to it. The following colour forms may be noted:—

Males.

Form 1. Head and prothorax of a clear reddish-flavous, entire elytra and parts of under-surface and of legs blackish,

or at least blackish-brown. The typical and fairly common form.

Form 2. As 1, except that the elytra are coloured as the prothorax, but with the sides more or less widely infuscated or black (a specimen of this species is standing, with others, as *pusilla* in the Macleay Museum, and another is the type male of *pallida)*. This is the most common form of the male; on some specimens the head is darker than the prothorax; the latter may have some slight infuscations, or be even darker than the elytra, and the elytral suture is also sometimes slightly infuscated (thus approaching Form 3).

Form 3. As 1, but with a pale oblique fascia on each elytron. A fairly common form, but the vittae vary in extent, and the head and prothorax are sometimes as dark as in Form 4.

Form 4. Coloured as described for the second male of the original specimens, one of which was identified by Macleay as *pusilla*. A rare form.

Form 5. As 1, but with two infuscated blotches on the prothorax; the head is also sometimes infuscated. A rather rare form.

Females.

Form 6. As 1, except that the abdomen is paler than the metasternum. A rather rare form, one of which is a cotype of the species.

Form 7. As 6, except that the elytra are bivittate. A cotype female belongs to this form, which is variable and not very common; the other cotype female might also be regarded as belonging to it; one of the females identified by Macleay as *pusilla* could also be referred to it, although its head and prothorax are dark, but not black.

Form 8. Entirely pale, except that the tips of some of the tarsal joints and the club of the antennae are more or less infuscated. This is the most common form of the female, and includes the type female of *pallida*. A rather dark specimen of it was in error labelled as *aphodioides* in the Blackburn collection.

There is also a female from the Blackburn collection that has the elytra pale, but with the margins infuscated: narrowly at the base, rather widely at the apex; much as on Form 2; but as there is but one specimen before me it has not been given a number.

Cheiragra atra, Macl.

In describing this species Macleay said he had only seen a male of it; but two specimens were pinned through the name label in the Macleay Museum; the type male, and a

female, the latter in error, as it is an unusually dark specimen of *pusilla*. Two other males before me agree with the type; one is from Sydney, the other, from the Blackburn collection, is without locality, but labelled "*atra*." They all have the prothorax with a somewhat sericeous appearance, but also with sharply-defined punctures; the elytra also have sharply-defined punctures, and by the punctures alone the species may be distinguished from black males of other species. The female is at present unknown.

CHEIRAGRA VITTATA, Macl. (formerly PHYLLOTOCUS).

This species, as yet known only from the Cairns district, was referred by Macleay to *Phyllotocus*, but the generic table by Blackburn indicates that it belongs to *Cheiragra*, as although the front claws of the male are less enormously developed than is usual in the genus, the four hind ones are much shorter than is usual in *Phyllotocus*, and each has a conspicuous membranous appendage. The sharply-defined pale vitta on each elytron of the male usually passes the middle, and occasionally includes the preapical callus, but it is sometimes much shorter; one specimen has the elytra entirely black. The female differs from the male in being rather more robust, the whole of the upper-surface shining, and the front claws no larger than the others, but the elytral margins are of the same shape. Of the six females before me one has the upper-surface entirely dark, the second is almost as dark but has the prothorax obscurely diluted with red near the base, and the bases of the elytral vittae obscurely indicated; the third has more of the base of the prothorax pale, and the elytral vittae larger and almost conjoined to form a triangle (the scutellum at the middle of its base being dark); the fourth and fifth each have the prothorax of a rather bright red, except for an apical and two small lateral infuscations; the elytra have the apical third (more at the sides) infuscated, the basal parts and the scutellum being of the same shade of red as the prothorax; the sixth specimen is in the National Museum and has the upper-surface entirely red. Lengths: ♂, 4-6·5 mm.; ♀, 5·5-7 mm.

CHEIRAGRA VARIABILIS, n. sp.

Pl. xxv., figs. 24 and 25.

♂. Colours variable. Prothorax, elytra, sterna, and abdomen opaque, owing to a conspicuous sericeous or pruinose bloom. Prothorax and elytra with a thin fringe of pale hairs or long setae, similar hairs on under-surface and legs.

Head shining; with fairly dense and sharply-defined punctures. Clypeus with slightly coarser punctures than

between the eyes, hind suture moderately distinct, not distinctly separated from labrum, sides and apex slightly elevated. Antennae eight-, club three-jointed, lamellae small. *Prothorax* not much wider than the greatest length, sides evenly rounded, front angles produced and acute, hind ones somewhat rounded off; punctures vaguely defined. *Elytra* rather strongly separately rounded at apex, sides gently rounded; striae and their contained punctures obscured by bloom; odd interstices slightly raised above and wider than the even ones. *Abdomen* small and curved to apex. Sides of hind *coxae* about one-third shorter than metasternum: tibiae stout, the front ones each with two large acute teeth and a very small one; front tarsi with four basal joints rather wide, the claw joint strongly notched near apex, and with very unequal claws, the larger one very large, strongly curved, and with a large basal appendix, the smaller one slightly larger than those on the other tarsi, and with its basal appendage similar but without a quill. Length (♂, ♀), 3·75-4·5 mm.

Cheiragra variabilis, Lea.

Cheiragra variabilis, Lea.

♀. Differs in having the upper-surface and part of the metasternum polished, prothorax slightly shorter, its punctures sharply defined, elytra with striae and their contained punctures sharply defined, and the interstices with distinct punctures: abdomen larger and more evenly convex,

legs shorter, the front claws even and no larger than the others, the basal appendix and quill as on the others.

Hab.—Queensland: Wide Bay (Macleay Museum), Brisbane (Queensland Museum from H. Hacker). Type, I. 10836.

A very variable species, of which there are at least two specimens of each colour form described below before me, and of which five forms have been taken in company by Mr. Hacker in October; they all have the basal joints of the antennae pale and the club dark.

Form 1, ♂. Black, head and scutellum somewhat paler, claws and front tibial teeth reddish. A specimen of this form has been made the type of the species.

Form 2, ♂. Of a dingy flavous or testaceous, head with base infuscated, prothorax with infuscated blotches, elytra with suture narrowly and sides and apex more or less widely infuscated or black, most of under-surface and of legs black or blackish. The blotches on the prothorax of this form vary from two small and obscure spots to four large longitudinal ones, covering most of the surface; occasionally the two median ones are conjoined so that there are but three blotches.

Form 3, ♂. Head, prothorax, scutellum, and parts of legs more or less brightly flavous (but not shining), elytra and most of under-surface and of legs black. On this form the head is infuscated from the base to the clypeal suture, and there are some vague infuscations on the prothorax.

Form 4, ♀. Head, prothorax, scutellum, front legs, and parts of the others of a bright flavous, elsewhere black. On this form the elytra are usually of a deep polished black, but on one small specimen parts near the suture are obscurely paler.

Form 5, ♀. Bright flavous, head and prothorax with vague infuscations, metasternum and parts of middle and of hind legs dark, abdomen partly or entirely pale. One Brisbane specimen has the vague infuscations of the head and prothorax as on this form, but with the elytra obscurely infuscated at the sides, approaching the following one; another in the Macleay Museum, from Wide Bay, has the upper-surface uniformly pale.

Form 6, ♀. Bright flavous, head more reddish, elytra with the sides and apex widely infuscated, metasternum, most of abdomen, and parts of legs blackish. The only two specimens of this form I have seen are in the Macleay Museum, from Wide Bay, and one of them has the infuscation of the elytra much more extended than on the other.

It is very difficult to distinguish some males of this species from some males of *ruficollis*, but the females may be readily

distinguished by the tips of the elytra (pl. xxv., figs. 23 and 25), these not being notched on the present one. Black males may be distinguished from males of *atra*, by the inconspicuous punctures of the upper-surface. From the real *pusilla*, of Blanchard, it is distinguished by its larger size; the outlines of the female elytra are somewhat similar, but the longer front portion of the front tarsi of the male is considerably longer and otherwise different. So far as the specimens before me indicate, however, the present species is confined to Queensland, and the others mentioned to New South Wales and Victoria. On fig. 24 the apical portion of the larger front claw of the male is shown as long and thin, as it appears from one direction, but from another it is seen to be strongly dilated to its base; and in fact the claw varies in appearance from every point of view.

Cheiragra sericeipennis, n. sp.

Pl. xxv., figs. 26 to 31.

♂. Colours variable. Prothorax, elytra, and parts of under-surface opaque owing to a sericeous or pruinose bloom. Prothorax and elytra with a few fringing setae.

Sculpture as described in preceding species except that the hind suture of the clypeus is better defined, that its suture with the labrum is marked by a series of conspicuous punctures, that the elytra are less distinctly separately rounded at apex, and that the front claw-joint with its claws are somewhat different. Length (♂, ♀), 3·25-3·9 mm.

♀. Differs in having the prothorax and elytra polished, with more distinct punctures, the elytra wider and each side near apex with a flange-like elevation, the abdomen larger, more convex, and the front claw-joint with its claws, much as the others.

Hab.—Queensland: Cairns district (Macleay Museum and F P. Dodd), South Johnstone River (H. W. Brown), Stradbroke Island (J. H. Boreham). Type, I. 4288.

A small species with the sericeous appearance of the elytra of the males very pronounced. The female may be distinguished from females of other species by the sides of the elytra, each of these near the apex has a somewhat convex flange, causing the apex to appear rather abrupt: from some directions and in certain lights each side appears to be notched (somewhat as on the females of *ruficollis*), but this is due to the part at the apparent notch being very thin, allowing light to show through. The average size of specimens is slightly more than that of *pusilla*, and distinctly less than that of *ruficollis*. On the male the fringe on each side consists of a few

widely-separated hairs or setae, on the female they are more numerous, but by no means dense. The front claw-joint of the male is deeply notched twice on the inner-side, leaving a thin truncated projection between the notches; the larger claw is strongly curved, from some directions appearing thin and acutely pointed, from others triangular and from others four-sided; its basal appendix is large, and also varies with the point of view; the smaller claw is very much smaller than the other, but its basal appendix is much as those on the other tarsi. The antennae usually have the club distinctly darker than the basal joints. There are at least five specimens of each of the following colour forms before me.

Form 1, ♂. Flavo-testaceous; elytra black, with a conspicuous bloom, abdomen blackish, metasternum more or less deeply infuscated, four hind tibiae, except at base, and tarsi blackish, or at least deeply infuscated. Includes the type.

Form 2, ♂. Flavo-testaceous; elytra black, with sericeous bloom very conspicuous and almost golden, an obscure reddish spot, sometimes extended into a short vitta, on each side of the scutellum; metasternum, abdomen, hind legs, and middle tibiae (except at base) and tarsi black or infuscated. On this form there are usually two large infuscated blotches on the prothorax.

Form 3, ♂. Flavo-testaceous; elytra of a lurid reddish-brown, abdomen and parts of four hind legs black or deeply infuscated. The bloom of the elytra is rather less conspicuous than on the other forms, and their lurid-red colour is sometimes partly extended on to the prothorax. Three males have the elytra of the same shade as in this form, except that the sides are infuscated; but of these two have the prothorax deeply infuscated, and of these again one (the only specimen examined from Stradbroke Island) has the base of the head infuscated. There are only three females before me, all without bloom; they all have the under-surface entirely pale, and the dark parts of the legs confined to the four hind tibiae and tarsi; two have the upper-surface entirely pale, but on the third the elytra are black.

Telura.

In Blackburn's table of the subtribe Sericoides [13] *Telura* is distinguished by "femora glabrous and very slender and elongate." But the femora of the only then known species, *vitticollis*, although elongate, are certainly not glabrous, as some bristles are present on each of them.

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[13] Trans. Roy. Soc. S. Austr., 1897, p. 32.

TELURA VITTICOLLIS, Er.

This species is fairly common at night on eucalyptus foliage in Tasmania, and it occurs also in New South Wales (Mount Kosciusko), Victoria (Mounts Buffalo and Hotham), and South Australia (Mount Lofty). Specimens vary from having the upper-surface entirely flavous, to the prothorax bivittate, and the elytra quadrivittate. Erichson described the club of the antennae as three-jointed, but this is true only of the female, and Waterhouse has already pointed out that in the male it is five-jointed.

TELURA CLYPEALIS, n. sp.

Flavous, basal two-thirds of head deeply infuscated (almost black), prothorax narrowly infuscated in middle of apex, and obscurely along middle to base, elytra with a sharply-defined and almost black vitta from base to near apex. Prothorax with four long hairs on each side, rest of upper-surface glabrous; under-surface and legs sparsely clothed, four segments of abdomen each with a transverse row of setiferous granules.

Head moderately convex, and with rather small punctures. Clypeus with apex conspicuously produced in middle, margins rather strongly upturned; punctures larger than between eyes but still small. Antennae nine-, club three-jointed. *Prothorax* moderately transverse, sides strongly and evenly rounded, front angles rather strongly produced and acute, hind ones rounded off; punctures small, varying slightly in size and density, but nowhere crowded. *Elytra* narrow, sides slightly dilated in middle; with regular striae, the sutural one with distinct but shallow punctures; interstices with fairly numerous, small, but sharply-defined punctures, becoming larger about base. *Pygidium* with minute and rather dense subasperate punctures. *Legs* long and thin; front tibiae strongly tridentate; basal joint of hind tarsi slightly shorter than second. Length, 11 mm.

Hab.—Western Australia: Beverley (E. F. du Boulay). Type (unique), I. 4835.

The narrow body, long and thin legs, tridentate front tibiae, eyes large and scarcely visibly faceted, and elytral striae not geminately arranged, indicate that this species, if not a *Telura* is extremely close to it, and provisionally, at least, may be referred to it; the clypeus is certainly very different to that of *vitticollis*, but in many allied genera it varies considerably. The vitta of the elytra is sharply defined, at the base it extends across four interstices on each, but it rapidly narrows till it only covers two, thence being parallel-sided almost to

its apex; on the prothorax the markings are obscurely defined; but it is probable that they are not constant. The three-jointed club may be indicative that the type is a female; each ramus is about the length of the apical spur of the front tibiae.

ODONTOTONYX RUFICEPS, n. sp.

Black; head, legs, antennae and palpi red, parts of under-surface obscurely diluted with red. Upper-surface glabrous, except for marginal fringes; under-surface, pygidium, and legs with long pale hair, denser on metasternum than elsewhere.

Head with moderately dense, sharply-defined punctures, rather small at base, larger in front. Clypeus semicircular, slightly concave, margins lightly upturned at sides, more strongly in front, hind suture curved backwards to middle; punctures near suture much as behind it, but sparser in front. Antennae nine-, club three-jointed and small. *Prothorax* about once and one-half as wide as long, sides strongly rounded and narrower at apex than at base, front angles produced and subacute, hind ones gently rounded off and slightly more than right angles; punctures much as on head but less crowded. *Scutellum* impunctate posteriorly. *Elytra* feebly dilated posteriorly, apex widely rounded; strongly striate, with shallow punctures in the striae, the interstices with scattered punctures, about as large as those on prothorax. *Pygidium* with dense and minute punctures. Front *tibiae* with two strong teeth and a very small one; basal joint of hind tarsi shorter than second, of the others longer than second; each claw with a fairly large basal appendix, and a whitish membrane. Length, 10½ mm.

Hab.—New South Wales: Hunter River. Type (unique), in Macleay Museum.

Distinguished from *brunneipennis* by being more robust, the prothorax and elytra black, apical tooth of front tibiae more curved, the second larger, and the third smaller (almost vanishing), the appendix to each claw (the sole character distinguishing *Odontotonyx* from *Nosphisthis*) is rather large but less sharply defined than in *brunneipennis*, and the membrane is somewhat smaller. There is a vague remnant of a median line on the pronotum.

PLATYDESMUS CASTANEUS, n. sp.

♂. Bright castaneous with a slight iridescence, head slightly darker than prothorax. Upper-surface glabrous, except for conspicuous prothoracic and elytral fringes; under-surface with rather sparse, irregularly distributed, golden hairs.

Head with numerous but not dense, and rather small sharply-defined punctures. Clypeus with sides rather lightly upturned, the front more strongly, hind suture gently curved backwards to middle; punctures somewhat larger and more crowded than between eyes. Antennae ten-, club four-jointed, rami of the latter curved, and about the length of the front tibiae. *Prothorax* not twice as wide as long, sides moderately rounded, front angles produced and acute, hind ones obtuse but sharply defined; punctures about as large but sparser than on head between eyes. *Scutellum* impunctate except at base. *Elytra* feebly dilated to beyond the middle, apex widely rounded; strongly striate, with distinct punctures in the striae, second, fourth, sixth, and eighth interstices slightly wider than the others, and with more numerous punctures. *Pygidium* with rather dense punctures, except along middle. Front *tibiae* strongly tridentate; basal joint of hind tarsi shorter than second. Length, 10·5-11·5 mm.

Hab.—New South Wales: Richmond River, in November (W. W. Froggatt). Type, I. 10785.

May be readily distinguished from *inusitatus*, the only other species having the club of the antennae four-jointed, by its larger size, less convex form, prothorax no darker than elytra, and with much smaller punctures, etc. I have seen specimens of this species in the Macleay Museum, from Port Denison.

ANODONTONYX INSULARIS, n. sp.

Of a pale dingy red, some parts darker. Upper-surface with some long hairs scattered about, and forming a fringe on each side of prothorax and elytra, a row of setiferous granules across most abdominal segments.

Head with dense punctures of moderate size, and a few larger ones scattered about. Clypeus with front margin rounded and rather strongly upturned. Antennae eight-, club three-jointed, second joint globular and distinctly wider than second, club small. *Prothorax* not twice as wide as long, sides subparallel on basal half, front angles lightly produced and subacute, hind ones rectangular and flat: punctures sparser and shallower than on head, but scarcely smaller; median line absent or very vague. *Scutellum* impunctate except at base. *Elytra* with fairly numerous, but not dense punctures, slightly larger than on prothorax; with feeble longitudinal elevations. *Pygidium* with fairly dense and rather small punctures. Basal joint of hind *tarsi* slightly longer than second. Length, 7-8 mm.

Hab.—Queensland: Stradbroke Island, October, 1911 (H. Hacker). Type, I. 4687.

The flattening out of the hind angles of the prothorax, and the clothing of the head associate this species with *nigro-lineata*, from which it may be distinguished by its much smaller size, and by the granules of the prothorax and elytra; before the type of *antennalis* was sent to the Britsh Museum I noted that in appearance it was close to some specimens of the present species, but the second joint of its antennae was described as "not at all thicker than the third joint," a character at once distinguishing it from the present and the two following species. They are referred to *Anodontonyx* on account of the small club, Blackburn somewhat unwillingly having recognized that as a valid distinction from *Scitala*. The smaller specimens (mostly males) usually have the prothorax and basal half of head darker than the elytra, sometimes almost black, the elytra usually have the suture and sides lightly infuscated, and sometimes each elytron has in addition three very vaguely infuscated discal lines (these being the feebly-elevated parts); the sterna are usually darker than the rest of the under-surface. From some directions the prothorax and elytra appear to be slightly iridescent, but from a few to have a conspicuous pruinose bloom; the head, however, is noniridescent from all points of view. The long hairs of the upper-surface each arise from a minute granule, they are fairly numerous, but not dense, between the eyes and on the front third of prothorax, on the elytra they appear to be sparsely scattered at random, but from directly in front or behind they are seen to be in rows on the feebly-elevated parts: on the abdomen the hairs are shorter, but the lineate arrangement is more distinct. The front tibiae have a large apical tooth and a much smaller subapical one: sometimes a feeble third tooth is indicated towards the base, but it is usually absent. Mr. Hacker obtained many specimens.

Anodontonyx opalescens, n. sp.

Dark piceous-brown obscurely mottled with red, but brilliantly opalescent. A few long hairs between eyes and across apex of prothorax, sides of prothorax and elytra fringed, rest of upper-surface glabrous; under-surface and legs very sparsely clothed.

Head with fairly dense punctures of moderate size, but sparse in middle. Clypeus almost truncate in front, margins rather strongly upturned. Antennae nine-, club three-jointed, second joint distinctly thicker than third and subglobular, club small. *Prothorax* about twice as wide as long, sides dilated in middle but narrowed to both base and apex, front angles produced and acute, hind ones rectangular, median line very feeble; punctures somewhat larger than on

head but sparser. *Elytra* rather long and thin, vaguely striated; with fairly large punctures. *Pygidium* with fairly dense punctures. Front *tibiae* tridentate, the two front teeth large, the other small; basal joint of hind tarsi slightly shorter and thicker than second. Length, 6·5-8 mm.

Hab.—New South Wales: Barrington Tops, January, 1916 (H. J. Carter). Type, I. 10779.

The hind angles of the prothorax are not so flattened as in *nigrolineata*, but as the head has some long hairs it possibly would have been associated with that species by Blackburn; it is certainly allied to it, differing in being much smaller and narrower, hind angles of prothorax sharper, etc. From some directions most of the upper-surface appears to be black, but from others much of the elytra of a dingy red, it is difficult, however, to see their true colours on account of the brilliant opalescence (this obscures the margins of the punctures, so that it is not easy to be sure of their exact size); from some directions even this changes to a pruinose gloss. One specimen, with much the same opalescence, has the elytra of a rather dingy red, with obscure darker lines.

Three specimens from Kurrajong (C. T. Musson) and Mittagong (H. J. Carter and A. M. Lea) possibly belong to this species, and are probably females; they differ in being much paler (almost uniformly castaneous), without opalescent gloss, with denser and larger punctures, especially on the elytra, where they are rather crowded and moderately large, and shorter legs.

ANODONTONYX NIGER, n. sp.

Black, shining; antennae, palpi, and legs dull red, prosternum and front of clypeus sometimes obscurely diluted with red. Prothorax and elytra with a thin fringe of reddish hairs, and a few hairs across apex of prothorax, rest of upper-surface glabrous; under-surface and legs sparsely clothed.

Head with fairly dense punctures at sides, but somewhat sparser in middle. Clypeus with margin rather strongly upturned in front but less strongly on sides, each side of base lightly produced, hind suture rather strongly drawn backwards to middle; punctures near base more crowded than between eyes, but becoming sparser in front. Antennae eight-, club three-jointed, second joint subglobular, distinctly wider than third; club small. *Prothorax* about twice as wide as long, front angles produced and subacute, hind ones gently rounded off; punctures rather small but sharply defined, nowhere crowded. *Elytra* rather short; with geminate rows or rather shallow punctures, the interstices with rather

numerous punctures. *Pygidium* with fairly dense punctures, a depression in each basal angle. Front *tibiae* wide and strongly tridentate; basal joint of hind tarsi longer and stouter than second. Length, 8-9 mm.

Hab.—Tasmania: Kempton, Parattah, Hobart (A. M. Lea), Brighton (Aug. Simson's No. 2850). Type, I. 819.

The male has longer and thicker legs than the female, and the sexes differ to a slight extent in the prothorax, its greatest width in the male being postmedian, in the female antemedian, in the male also it is less transverse than in the female, hence the characters used in Blackburn's table[14] are unsatisfactory; but of the species known to Blackburn it seems closest to *tetricus*, from which it differs in its smaller size, much smaller elytral punctures, less convex elytral interstices and red legs; it is without the metallic gloss of *micans*, and differs in other respects from that species. The median line of the prothorax is either absent or vaguely impressed for a short distance near the base. Countless thousands of specimens of this species are sometimes washed up on the beaches near Hobart, after sultry nights.

Pseudoheteronyx seticollis, n. sp.

Pl. xxvi., fig. 61.

Black; antennae, palpi, and parts of tarsi obscurely reddish. Head and prothorax with dense and extremely short suberect setae; abdomen and pygidium with longer and sparser setae, parts of legs, front wall of clypeus, angles of prosternum, and margins of elytra with still longer setae, or stiff hairs.

Head smooth and impunctate at base, elsewhere with crowded (but not confluent) and rather shallow punctures of moderate size. Clypeus with punctures as on rest of head, front margin feebly incurved to middle, hind suture appearing as a narrow sinuous elevation. Antennae eight-, club three-jointed. *Prothorax* widely transverse, sides gently rounded, base very feebly bisinuate, front angles produced and acute, hind ones lightly rounded off, median line feeble; punctures somewhat smaller than on head, but quite as dense. *Elytra* with sides gently and apex widely rounded; with rather feeble relics of striation; punctures slightly larger, sparser, and more sharply defined than on prothorax. *Pygidium* with irregularly distributed, asperate punctures. Front *tibiae* strongly tridentate; basal joint of hind tarsi slightly longer than second, each claw with a strong basal appendix. Length, 11·5-15 mm.

[14] Trans. Roy. Soc. S. Austr., 1907, p. 258.

Hab.—New South Wales: Mount Kosciusko (B. Ingleby, — Lucas, and — Guerand, 7,000 ft., in Howitt's collection). Type, I. 589.

A strongly-convex dull species, but with shining elytra. Specimens vary somewhat in the punctures of the elytra and one has a few fairly well-defined striae, but all agree in having the prothorax with very dense punctures, with a minute seta arising from each: on many of them the setae have caused mud to adhere uniformly to the surface, giving it a curious appearance; the setae on the upper-surface of the head are just as dense, but from several specimens have been completely abraded; the elytra have a few extremely minute setae towards the sides, but from most directions they are invisible. The apex of the scutellum is without punctures, the apparent base has a few large ones, and the real base (normally concealed by the overlapping base of the prothorax) has dense ones. I have been unable to find external indications of sex in the eleven specimens under examination. The eight-jointed antennae and general appearance associate the species with *baldiensis* and *creber*, from which it may be readily distinguished by the prothoracic clothing.

Pseudoheteronyx basicollis, n. sp.

Pl. xxv., figs. 32 and 33; pl. xxvi., fig. 62.

Black; parts of antennae, of palpi, and of tarsi obscurely reddish. Upper-surface sparsely clothed with short, depressed setae, more numerous (but still not very dense) on head than elsewhere; prothorax and elytra fringed with stiff blackish setae, similar setae on parts of under-surface and of legs.

Head with numerous, but not very dense or large, and rather shallow punctures, becoming crowded on clypeus: front margin of the latter gently incurved to middle, hind suture lightly impressed and sinuous. Antennae nine-, club three-jointed. *Prothorax* scarcely twice as wide as long, sides strongly and evenly rounded, base evenly incurved to middle, front angles produced and subacute, hind ones rounded off, median line absent; punctures similar to those on head but sparser, a few very small ones scattered about. *Scutellum* with numerous punctures. *Elytra* with sides gently rounded and apex almost truncate; punctures slightly larger than on prothorax. *Pygidium* and *metasternum* with rather coarse punctures. Front *tibiae* strongly tridentate; two basal joints of hind tarsi subequal; claws strongly appendiculate.

Hab.—Australia: (Blackburn's collection); Queensland: Toowoomba (Hamlyn Harris in Queensland Museum); New South Wales (National Museum). Type, I. 4847.

The majority of the punctures on the upper-surface are so impressed that there appears to be a minute granule (often semicircular) at the back of each, but the granules are invisible from in front, they are decidedly coarser on some specimens than on others; in some specimens faint indications of elytral striae may be seen, but from others these are entirely absent; the lateral bristles each arise from a small granule. The front claws (fig. 32) are of very different shape to the others (fig. 33), and the difference is apparently not sexual (at least I have been unable to find external indications of sex in the nine specimens under examination); its upper-surface is subopaque owing to very fine shagreening. The nine-jointed antennae associate the species with *laticollis* and *helaeoides* in Blackburn's table; from which, as from all other described species of the genus, it may be distinguished by the base of the prothorax, this being gently and evenly incurved from each side to the middle; on all other species the base is gently bisinuate, with the part adjacent to the scutellum in the form of a wide feeble lobe. It is rather more convex than the preceding or following species.

Pseudoheteronyx puncticollis, n. sp.

Pl. xxvi., fig. 63.

Black; antennae, palpi, and parts of tarsi more or less reddish. Upper-surface almost glabrous; under-surface and legs sparsely setose.

Head with large and rather deep, but not crowded, punctures, suddenly becoming crowded on clypeus; the latter with apex gently incurved to middle. Antennae nine-, club three-jointed. *Prothorax* about thrice as wide as the median length, sides strongly rounded, base very feebly bisinuate, front angles rather strongly produced and acute, hind ones slightly rounded off; median line absent; with large deep punctures, becoming smaller towards sides, somewhat irregularly distributed but nowhere crowded. *Elytra* with sides gently rounded, apices very feebly rounded (almost truncate); with irregular rows of rather large punctures, in wide, shallow striae. *Pygidium* with very shallow punctures. Front *tibiae* strongly tridentate; basal joint of hind tarsi slightly longer than second; all claws acutely appendiculate. Length, 11 mm.

Hab.—Queensland: Camooweal. Type (unique), in Queensland Museum.

The head and prothorax are opaque, the elytra moderately shining; the whole of the body and even parts of the legs are very finely shagreened. There is a short seta in most of the punctures of the upper-surface, but they are very inconspicuous, as they seldom rise to the general level. The hind suture

of the clypeus is not very distinct by itself, but is rendered very distinct by the difference in the density of the punctures before and behind it; there are about ten distinct striae on each elytron, the punctures in each do not form a regular row at the deepest part, but many are on the sloping parts, although they could scarcely be regarded as geminately arranged; each of them, when viewed from behind, appears to have a small basal granule. The nine-jointed antennae associate this species with *laticollis* and *helaeoides*, in Blackburn's table, from which it may be distinguished by the longer basal joint of the hind tarsi; the punctures of the head and prothorax approach those of *laticollis*, but the elytral sculpture is very different; the hind tarsi were not mentioned in the description of *laticollis*, but two specimens (received from Mr. Carter and taken by Judge Docker at Walgett, as was the type) of that species before me have the basal joint decidedly shorter and thicker than the second.

Byrrhomorpha rudis, n. sp.

Black; antennae, palpi, and parts of tarsi reddish. Metasternum with fairly numerous blackish hairs, rest of under-surface and legs sparsely clothed.

Head with crowded but sharply-defined punctures of moderate size. Clypeus widely excavated in front, sides rather strongly elevated, hind suture in the form of a narrow carina; punctures as between eyes, but becoming smaller on sides. Labrum conspicuously elevated in front, deeply impressed along middle, the impression continued on to mentum, but much shallower there. Antennae nine-, club three-jointed. *Prothorax* scarcely twice as wide as long, sides decreasing in width from near base to apex, front angles rather strongly produced and acute, hind ones somewhat obtuse; median line rather feeble at base, but rather wide and deep in front; punctures much as on head, but becoming smaller (although not sparser) towards all margins. *Scutellum* with dense punctures, but tip polished and impunctate. *Elytra* feebly dilated to beyond the middle, each obliquely truncate at apex; striae deep and wide, with coarse, irregular punctures, the interstices irregular, and with sharply-defined punctures. *Pygidium* with crowded asperate punctures, and a distinct median line. Front *tibiae* strongly tridentate. Length, 8-11·5 mm.

Hab. — Western Australia: King George Sound (Macleay Museum), Warren River (W. D. Dodd). Type, I 4836.

A rough-looking species close to *verres*, but club with only three joints, prothorax with more crowded punctures,

and with a conspicuous enlargement of the median line; the largest is less than the length noted for *ponderosa*. The coarse punctures are often confluent on the sides near the shoulders. The elytra of this and of the following species (except for marginal fringes) at first glance appear to be glabrous, but they have sparse and exceedingly short pubescence, that even under a strong lens appears hardly more than dust.

VARIETY. One specimen has the front tibiae bidentate; but agrees in other respects with the type and seven other specimens.

BYRRHOMORPHA BASICOLLIS, n. sp.

Black; most of under-surface, and of legs, labrum, and sides of clypeus, obscurely reddish-brown, antennae paler. Parts of under-surface and of legs with rather long, yellowish hairs or bristles.

Head with crowded and small but sharply-defined punctures. *Prothorax* with crowded, small, and rather shallow, but sharply-defined punctures, frequently transversely or obliquely confluent. *Elytra* with punctures of moderate size, but (except at the apex where they are smaller and denser) not crowded or confluent. *Pygidium* with very dense and small asperate punctures, with a very feeble median line. Front *tibiae* tridentate, the two front teeth large and acute, the other very small. Length, 9-10 mm.

Hab.—South Australia: Lucindale (B. A. Feuerheerdt and F. Secker), Sandy Creek (J. G. O. Tepper). Type, I 4837.

The under-surface is sometimes uniformly dull reddish-brown; on two specimens the abdomen is almost black, and darker than the sterna, on another it is considerably paler than the sterna. On the head of one specimen there is a very conspicuous, narrow, impunctate line near the base; but this appears to be due to less of its back part being concealed by the apex of the prothorax than in the others. The subsutural and sublateral striae of the elytra are in parts fairly well defined, but there are no distinct discal striae, their places being taken by obscure and subgeminate rows of punctures, scarcely differing in size from those in their vicinity. There is an enlargement of the median line of the pronotum, as in the preceding species, but the punctures of the prothorax and elytra are very much finer than on that species; the clypeus (except that its punctures are smaller), labrum, mentum, outlines of prothorax and of elytra, and the scutellum are as described in that species. From *verres* it is readily distinguished by the much denser and finer punctures of the prothorax, which are also frequently confluent; the sculpture

of the elytra is also much finer, and the subgeminate arrangement of punctures, although feeble, is more regular.

Frenchella gagatina, n. sp.

Pl. xxvi., fig. 64.

Black, highly polished; parts of antennae and of palpi reddish. Upper-surface glabrous, except for fringes of dark hairs on the prothorax and elytra; under-surface and legs with blackish hairs, denser on metasternum than elsewhere.

Head with dense (but not crowded) and sharply-defined punctures of moderate size between eyes. Clypeus with suture gently sinuous; punctures (except in front) crowded and slightly larger than those between eyes. Antennae nine-, club three-jointed and rather small. *Prothorax* about twice as wide as long, sides strongly rounded in middle, front angles produced and acute, hind ones obtuse but not rounded off; punctures about as large as those between eyes, but sparser and becoming smaller on sides. *Scutellum* impunctate on apical half. *Elytra* slightly dilated to beyond the middle, apex gently rounded; each with ten well-defined striae containing numerous punctures, these of varying sizes but mostly fairly large; interstices with a few distinct punctures. *Pygidium* in parts with sharply-defined punctures. Front *tibiae* tridentate, the two front teeth large, the other very small. Length, 12·5 mm.

Hab.—Western Australia: Cue (H. W. Brown). Type (unique), I. 4780.

As the club is rather small the type is probably a female; the median line of its pronotum is vaguely impressed on the apical third, and represented by an impunctate line from there to the base. The hind angles of the prothorax are sharply defined, although they are rather more than right angles, but this is the case with other species that Blackburn referred to B of his table, "Hind angles of prothorax sharply defined," from some directions, however, they appear to be quite sharply acute; by that table the species would be associated with *sparsiceps*, which is a narrower and paler species, with much sparser punctures between eyes, etc. It is darker and more strongly convex than any previously-described species, in appearance closer to some dark specimens of *lubrica* than to any other, but differing by the absence of punctures from the greater portion of the elytral interstices, clypeus much less upturned in front, and front tibiae apparently bidentate at first glance, the third tooth being very feeble and nearer the base than in other species.

Frenchella fimbriata, n. sp.

Pl. xxvi., fig. 65.

Dark reddish-castaneous and highly polished; under-surface, legs, antennae, and palpi paler. Upper-surface glabrous, except for fringes of reddish bristles on the prothorax and elytra, a similar fringe on pygidium; under-surface moderately clothed in places.

Head with sharply defined but not very large punctures, sparser between eyes than elsewhere. Clypeus convex in middle, its hind suture almost straight; punctures crowded and slightly larger than those behind suture. Antennae nine-, club three-jointed. *Prothorax* not twice as wide as long, sides moderately rounded in middle, oblique to apex, with front angles produced and acute; feebly decreasing to base, with hind angles rectangular; base feebly bisinuate; punctures sharply defined and nowhere dense. *Scutellum* impunctate at apex. *Elytra* gently and evenly dilated to beyond the middle, apex widely rounded; strongly striate, with rather small punctures in striae near suture, becoming rather large towards sides, the interstices with few but sharply-defined punctures. *Pygidium* with slightly larger punctures than on prothorax. Front *tibiae* tridentate. Length, 11 mm.

Hab.—Queensland: Bowen (Simson's collection, No. 2007). Type (unique), I. 10782.

A less convex species than usual; the type appears to be a male, as the rami of the club are longer than the other joints of the antennae combined; the apical tooth of the front tibiae is long and acute, the second one is acute but small, and the third is very small; the basal joint of the hind tarsi is thick, and its full length is greater than that of the second, but from some directions it appears to be slightly shorter. Regarding the species as belonging to AA, B, of Blackburn's table, it would be associated with *sparsiceps*, from which it differs in its much darker colour, prothorax with sparser and more sharply-defined punctures, rather denser punctures between eyes, elytra more dilated posteriorly, pygidium with much larger punctures, etc.; if it was regarded as belonging to AA, BB, it would be associated with *lubrica*, which has much denser punctures, including many on the elytral interstices, and differs in other particulars.

Frenchella cribriceps, n. sp.

Pl. xxvi., fig. 66.

Black and highly polished; palpi and parts of antennae and of front legs more or less reddish. Upper-surface sparsely clothed, but with distinct reddish fringes, pygidium with

rather long pubescence and a distinct fringe, sterna densely pilose.

Head rather convex, and with rather large, crowded punctures. Clypeus with margins rather strongly upturned, hind suture curved backwards to middle; punctures much as between eyes, but becoming smaller in front. Antennae eight-, club three-jointed. *Prothorax* distinctly less than twice as wide as long, sides subangularly produced in middle, rather strongly narrowed to apex, with front angles produced and acute, less strongly narrowed to base, with hind angles sharply defined and almost rectangular; punctures almost evenly distributed, sparser, and smaller than on head. *Scutellum* with rather sparse punctures. *Elytra* almost parallel-sided to near apex, which is almost truncate; striae well defined, but with irregular punctures; interstices with rather large, irregularly-distributed punctures. *Pygidium* with dense, subasperate punctures about base, becoming sparser elsewhere. Front *tibiae* strongly tridentate; basal joint of hind tarsi shorter than second. Length, 11·5 mm.

Hab.—South Australia: Lucindale (F. Secker). Type (unique), I. 4700.

As the club is small the type is probably a female. There are fairly numerous erect hairs between the eyes, and sparse ones on the elytra; but the type has probably been partly abraded. There is a feeble remnant of a median line on the pronotum. By Blackburn's table the species would be associated with *hispida*, from which it differs in being black, clothing of upper-surface much sparser, clypeus longer, etc. In general appearance it is fairly close to dark specimens of *lubrica*, but that species has denser prothoracic and elytral punctures, antennae nine-jointed, etc.

Engyops flavus, n. sp.

Flavous, front of head and parts of legs castaneous. A few long hairs between eyes, and a fringe of similar hairs on each side of the prothorax and elytra, rest of upper-surface glabrous; pygidium moderately densely clothed at apex; under-surface and legs very sparsely clothed.

Head with fairly numerous and small but sharply-defined punctures. Clypeus with semicircular and rather strongly upturned margins, middle rather strongly convex and with denser and coarser punctures than between eyes; hind suture sharply defined. Antennae nine-, club three-jointed. *Prothorax* about twice as wide as long, side subparallel on basal two-thirds, and then strongly rounded to apex, front angles produced and acute, hind ones almost rectangular; punctures somewhat larger and denser than

between eyes. *Scutellum* with punctures as on prothorax. *Elytra* slightly dilated to beyond the middle, and then narrowed to apex, where each is obliquely truncated but with a fine membrane; with regular impunctate striae, interstices with slightly larger punctures than on prothorax, but not quite so dense. *Pygidium* with crowded punctures. *Undersurface* with rather dense and strong punctures, sparser and smaller on parts of abdomen than elsewhere. Front *tibiae* tridentate, the two apical teeth large, the other feeble; basal joint of hind tarsi as long as the second and third combined. Length, 8·5-9 mm.

Hab.—Queensland: South Johnstone River (H. W. Brown), Innisfail (Mrs. McArthur), Mackay (National Museum, from R. E. Turner). Type, I. 10781.

An elongate species, at first glance resembling some species of *Phyllotocus (e.g., occidentalis*, and the variety *pallidus* of *macleayi)*, but with very different front parts of head, etc. The very large eyes with the space between them not much wider than long, simple claws (they are, however, thickened at the base), and general appearance are as in *E. spectans*, from which it differs in being much larger, clypeus shorter, punctures (especially on elytra) denser, etc., the elytra are also truncated at apex; the mentum is granulate but much less densely clothed than in *spectans*. From above the hind angles of the prothorax appear to be acute, and to slightly embrace the elytra, but from the side each is seen to be almost rectangular. The sparse hairs on the head are partly in front of and partly behind the clypeal suture. Each ramus of the club is about as long as the inner spur of the front tibiae. The four specimens under examination appear to be all males.

HAPLOPSIS SERRICOLLIS, n. sp.

Black with a slight bronzy gloss, antennae (except club) and palpi red, tips and part of sides of elytra and parts of legs obscurely diluted with red. Rather densely clothed with long white hair.

Head with coarse and dense punctures. Clypeus with margins moderately upturned, front truncate but with corners rounded off, the sides oblique. Antennae nine-, club three-jointed, rami about the length of the claw-joint without the claws. *Prothorax* not twice as wide as long, sides strongly rounded and finely serrated, front angles produced and acute, hind ones obtuse but not rounded off; punctures large and asperate; the interspaces with dense small punctures. *Elytra* with subgeminate rows of close-set, asperate punctures, the wider interstices with numerous gaps on each side due to

punctures. *Pygidium* with crowded punctures. Front *tibiae* tridentate, the two first teeth large and acute, the third small, acute, and subbasal; basal joint of hind tarsi much shorter than second. Length, 6-6·25 mm.

Hab.—Western Australia: Cunderdin, July-August, 1913 (Western Australian Museum, No. 7813). Type, I. 10797.

In size and structure close to *olliffi*, with which it would be associated in Blackburn's table, but the elytra have much longer clothing, and with scarcely a trace of metallic gloss; *debilis* has the clypeus somewhat different, the metallic gloss of elytra more conspicuous, and the clothing shorter; the tips of the elytra are obscurely reddish as in *grisea*, but the clothing of that species is much shorter and the clypeus is very different. On the upper-surface there are fairly dense subdepressed hairs, each about the length of a claw, and mixed with these (and very distinct from the sides) are longer erect ones, fairly dense on the head to base of elytra, but disappearing before the apex of the latter. From some directions the prothorax appears to be covered with small granules, much as in many small weevils (*e.g.*, *Essolithna*, *Polyphrades*, etc.). The semidouble rows of elytral punctures are very irregular, and are in shallow longitudinal impressions, but these could scarcely be regarded as striae; on each elytron there are three interstices that are conspicuously wider than the others, but all have jagged edges due to punctures. The clothing somewhat obscures it, but the whole of the derm appears to be very finely shagreened.

Maechidius hackeri, n. sp.

Castaneous, some marginal parts darker, club paler. Moderately densely clothed with long, erect, golden or light-brown hairs; parts of under-surface with rather sparse, subdepressed pubescence.

Head with coarse and rather crowded punctures. Clypeus deeply notched in front, each side conspicuously trilobed. Antennae with the club three-jointed. *Prothorax* about twice as wide as long, sides moderately rounded and finely serrated, front angles produced and moderately acute, hind ones obtuse and entire; punctures as large as on head, but less crowded. *Elytra* feebly dilated to beyond the middle, with double rows of large punctures. *Pygidium* convex, with asperate, setiferous granules. Front *tibiae* tridentate: each claw with a conspicuous basal quill. Length, 8 mm.

Hab.—Queensland: Buderim Mountain, in April (H. Hacker). Type (unique), in Queensland Museum.

The hairs are more conspicuously golden and denser on the pygidium than elsewhere. In Blackburn's table the species would be associated with *macleayanus*, from which, as from all other species except *variolosus* and *pilosus*, it may be readily distinguished by the long erect clothing of the upper-surface; from the two latter species it may be distinguished by the quilled claws; in general appearance it is strikingly close to *variolosus*.

Maechidius stradbrokensis, n. sp.

Blackish, some parts obscurely paler, antennae and palpi reddish. Head and prothorax with rather long, stiff, erect, rusty-red bristles, somewhat similar but shorter and paler ones on pygidium, elytra with subdepressed whitish setae, and a few suberect bristles; under-surface and legs with moderately dense, short, curved setae.

Head with large dense punctures between eyes. Clypeus strongly convex and with crowded punctures in middle, widely emarginate in front, each side with two triangular teeth, and a longer and more obtuse one extending to base. Antennae with club three-jointed. *Prothorax* about twice as wide as long, sides obtusely serrated, front angles produced, base strongly notched on each side; punctures large, round, and shallow. *Elytra* almost parallel-sided to near apex; with rows of large, elliptic, ring punctures. *Pygidium* with a large median fovea. Front *tibiae* strongly tridentate; each claw with a conspicuous basal quill. Length, 9-11·5 mm.

Hab.—Queensland: Stradbroke Island, in December (H. Hacker). Type, in Queensland Museum; cotype, I. 10795, in South Australian Museum.

In general appearance somewhat close to a species doubtfully identified by Blackburn as *emarginatus*, with which it would be associated in his table, but readily distinguished by the stiff bristles of the head and prothorax; on *excisicollis* the prothorax has much thinner setae, and the basal excavations and elytral sculpture are different; *insularis* is much smaller and otherwise very different.

Maechidius hopeanus, Westw.

M. obscurus, Macl.

The types of *obscurus* agree with specimens identified (correctly I think) by Blackburn as *hopeanus*. Macleay described the prothorax as "shallowly bifoveate near the sides with the median line lightly marked." One of the specimens certainly appears to be bifoveate, but the other has vague depressions only (much as on typical specimens of

hopeanus); the lightly-marked specimen is also without a median line.

Maechidinus, n. g.

Head rather small. Eyes small and lateral. Clypeus entire in front, its basal angles slightly exterior to eyes. Maxillary palpi small, the labial ones very small. Antennae nine-, club three-jointed and rather small. *Prothorax* not much wider than greatest length; hind angles semicircularly excised. *Scutellum* semicircular. *Elytra* not covering the propygidium and pygidium. *Prosternum* with a W-shaped excavation in front for reception of antennae, one of which rests on each side of a triangular intercoxal process. *Legs* rather stout; front tibiae tridentate, the third tooth small and close to the base; claws long, thin, and simple.

This genus appears to be allied to *Caulobius*, and its front tibiae are much as in that genus and *Automolus*, but the prosternal sutures are widely open, allowing the antennae to be concealed when at rest, as in *Maechidius*; a notch on each side of the base of the prothorax is often present in *Maechidius*, near which the genus should be placed in catalogues; but it is readily distinguished therefrom by the entire clypeus, exposed propygidium, and great distance between the second and third teeth of the front tibiae.

Maechidinus latericollis, n. sp.

Black; palpi, claws, and parts of antennae reddish. Upper-surface with stout depressed setae, or lanceolate scales, dense and mostly black on head, dense and white on sides of prothorax, and black in middle, irregularly distributed and sparser on elytra; under-surface, pygidium, propygidium, and parts of legs closely plated with snowy-white scales, legs in addition with numerous long whitish hairs, tips of abdomen and of pygidium with golden setae.

Head with dense, partially concealed punctures. Clypeus widely transverse, front truncate, sides gently rounded, hind suture normally concealed. *Prothorax* strongly convex, sides strongly rounded, at about the basal third with a small tooth marking the outer end of a strong basal notch, front angles produced and acutely triangular; median line shallow; punctures crowded and moderately large. *Elytra* with irregular rows of punctures, many of which are separated by small transverse shining granules, interstices of uneven width and obtusely serrated. Basal joint of hind *tarsi* conspicuously shorter and thicker than second. Length, 7-9·5 mm.

Hab.—Western Australia: Beverley (E. F. du Boulay). Type, I. 4583.

To see the W-shaped excavation of the prosternum clearly it is necessary to remove the head; from most directions it is difficult to see the line dividing the front face of the clypeus from the labrum. The clothing is remarkable, especially on the elytra, where the setae or scales on perfect specimens seem to be in geminate rows, with the white ones stouter than the black ones, and either lanceolate in shape, or elongate-elliptic; on the upper-surface even where dense the derm may usually be seen from an oblique direction, but on the hind-parts and the under-surface the scales are so dense and flat that most of the derm is hidden.

Maechidinus marginalis, n. sp., or var.

Ten specimens differ from *latericollis* in having the prothorax wider, its clothing longer and more upright, the pale setae continued across both base and apex (on all the specimens of *latericollis* the pale clothing is confined to the sides), clothing of head longer and almost entirely pale, under-surface with clothing more setose in character, even on the abdomen (where the scales are all distinctly longer than wide, and many are longitudinally ribbed) and the hairs on the legs longer and denser. Length, 8-9 mm.

Hab. — Western Australia: King George Sound (Macleay Museum). Type, I. 10796.

There are ten specimens of the present form before me, all from King George Sound; and six of *latericollis*, all from Beverley, so that the differences noted are unlikely to be sexual; the curious front tibiae and lateral notches of prothorax are exactly alike on the two forms, but the distinctly wider prothorax of the present form is unlikely to be of varietal importance only. A specimen of this form was standing in the Blackburn collection at the end of *Automolus*, but it was damaged and the head was so mouldy that the antennae were concealed, hence he probably regarded them as broken off, and so refrained from describing it.

Cryptodus.

It is difficult and in many instances impossible, unless they are dissected out, to count the joints of the antennae of species of this genus, owing to the greatly dilated basal joint concealing some of the following ones, and to the brevity of the joint preceding the club, the latter I have presumed in every instance to be three-jointed. Probably Fairmaire dissected them out to make certain of them, as I have had to do in many instances, thus making certain that his counts of the antennae of *variolosus* and *piceus* as being nine-jointed

were correct. Of the species described by him the following comments are offered: —

grossipes. A very distinct species, with the base of the mentum much as in *caviceps*, but the two species otherwise very different.

creberrimus. I cannot find that Blackburn has anywhere published a note as to *creberrimus* being a synonym of *paradoxus*, but at the side of his copy of the description of *creberrimus* he wrote "= *paradoxus* Macl." and the description agrees so well with ordinary specimens of that species that I also regard it as *paradoxus*. It is probable that some of Fairmaire's other names are bestowed upon forms of the same variable species.

fraternus. Although placed in A, species noted as having "antennae novem-articulatae. Mentum emarginatum," this species was said to have ten-jointed antennae, and the mentum was not even mentioned. Probably it was accidentally referred to A, and as the species of B were divided into three groups, dependent on the form of the mentum, it would be unsafe to identify any specimens as *fraternus*, without additional particulars to those given in the description (which is simply a brief comparison with *cycnorum*).

Cryptodus paradoxus, W. S. Macl.

C. subcostatus, Macl.

C. obscurus, Macl.

The types of *subcostatus* are quite ordinary specimens of *paradoxus;* the types of *obscurus* differ from those of *subcostatus* in the particulars mentioned by Macleay, but the differences are individual rather than specific. The life the insects lead naturally causes older specimens to lose much of their gloss; the antennae of the four specimens are almost or quite buried within their cavities, but appear to be quite as in *paradoxus.*

Cryptodus incornutus, Macl.

The type of *incornutus* is certainly very close to *paradoxus*, the general outlines of the head, prothorax, and elytra (and the subapical tuberosities of the elytra) are very much the same; the deeply-notched mentum, the antennae, and legs are also very similar, but the complete absence of cephalic tubercles (they are, however, often very feeble on *paradoxus)*, the decidedly coarser prothoracic, and the generally coarser punctures, may be distinctive.

A smaller and even rougher specimen also with nontuberculate head was sent to me some years ago by Mrs. Hobler of Dalby; and has been considered a possible variety of *paradoxus.*

Cryptodus variolosus, White.

Mr. Clark and I have taken specimens of this species in abundance from nests of *Iridomyrmex conifera*, in many parts of Western Australia.

Cryptodus passaloides, Germ.

Mr. Clark and I have taken specimens of this species from nests of several species of ants in Western Australia, including *Ponera lutea*, and a small black *Iridomyrmex*.

Cryptodus foveatus, n. sp.

Pl. xxvii., fig. 85.

Dark brown, sometimes almost black, moderately shining. Upper-surface with very short, and rather sparse, golden setae.

Head with crowded reticulate punctures, a feeble median depression and two feeble tubercles. Clypeus with margins rather strongly upcurved, middle feebly incurved. Mentum with base deeply semicircularly notched, and with two rather acute processes; with dense, reticulate sculpture, becoming sub-obliterated in front. Antennae ten-jointed; basal joint strongly dilated to apex. *Prothorax* with fairly large, and rather dense, shallow punctures, each with a central pit, but becoming crowded and irregular on the sides in front, median line rather lightly defined, but with slightly larger punctures than on the adjacent surface. *Elytra* with rather large elliptic or round punctures, each with an elevated median line, the interstices with numerous sharply-defined punctures; costae distinct. *Pygidium* with a large median depression, with dense, reticulate sculpture, reduced to simple punctures at apex. Front *tibiae* quadridentate, the subbasal tooth small, the others large. Length, 20-23 mm.

Hab.—Northern Territory (Blackburn's collection), Daly River (H. Wesselman), Darwin (N. Davies); Queensland, Charters Towers (Blackburn's collection). Type, I. 2259.

Very distinct from all other known species by the large depression or fovea on the pygidium, which is distinct to the naked eye and gives that organ a bituberculate appearance (thinking this was possibly a masculine character one specimen was dissected, without an aedeagus being found); the quadridentate front tibiae is also a useful, but not unique, distinguishing feature. The five specimens before me have all simple front tarsi.

Cryptodus antennalis, n. sp.

Pl. xxv., figs. 34 and 35; pl. xxvii., fig. 86.

Dark brown and moderately shining. Upper-surface with sparse and very minute setae.

Head with dense, reticulate sculpture, becoming laminate in front; with a scarcely traceable median depression. Clypeus rather strongly elevated in front, less so on sides, the hind suture marked by a finely-elevated line, but not traceable across middle. Mentum with base deeply notched and bidentate; densely reticulate, but the sculpture subobsolete in front. Antennae ten-jointed, basal joint strongly dilated and lop-sided in front, the following joint inserted slightly nearer its base than apex. *Prothorax* with rather large and dense ring punctures, each with a central pit; median line feebly defined or absent. *Elytra* with rather large, elliptic, ring punctures, becoming smaller, denser, and rounder on sides; costae well defined. *Pygidium* with numerous ring punctures, each with a central pit, becoming crowded in corners, and almost simple at apex. Front *tibiae* strongly tridentate. Length, 16-21 mm.

Hab.—New South Wales: Mulwala, Coonabarabran (Blackburn's collection from T. G. Sloane); Queensland: Bowen (Aug. Simson's No. 4294). Type, I. 2266.

The general sculpture is somewhat as in *paradoxus*, but the surface is more polished, and the antennae are ten-jointed; the basal joint is so wide, with its tip overhanging the base of the club, that it is impossible to count the joints before dissection. The head has two very feeble elevations, and these are sometimes so ill-defined that they might fairly be regarded as absent. The punctures on the front sides of the prothorax are larger than elsewhere, and do not degenerate into crowded scratches. There are seven specimens before me, all with simple front claws.

Cryptodus angustus, n. sp.

Pl. xxvii., fig. 87.

Dark brown and shining. Upper-surface with sparse and extremely short setae.

Head with coarsely reticulate sculpture, becoming finer in front; with a shallow median depression, on each side of which is a feeble elevation. Clypeus moderately elevated in front, rather feebly on sides. Mentum with base deeply notched and strongly bidentate; with coarse reticulate sculpture, becoming finer in front. Antennae ten-jointed, basal joint strongly dilated to apex. *Prothorax* with fairly dense shallow punctures, each with a central pit, becoming crowded on the sides in front; median line feeble. *Elytra* with large, shallow, elliptic, ring punctures, becoming smaller and rounder towards sides, interstices with rather sparse and small but sharply-defined punctures; costae rather feeble. *Pygidium*

with more or less crowded ring punctures. Front *tibiae* quadridentate, the subbasal tooth small, the others strong. Length, 16-22 mm.

Hab.—Northern Territory: Darwin (Sir E. C. Stirling, N. Davies, W. K. Hunt, and Blackburn's collection); Queensland: Stewart River (W. D. Dodd). Type, I. 136.

An oblong, flat species, decidedly narrower than usual. Three of the specimens before me were doubtfully identified by Blackburn as *oblongoporus*, but that species was the first to be referred to Fairmaire's first section of the genus distinguished by having nine-jointed antennae, the front tibiae were also described as tridentate. The description of *fairmairei* was simply a comparison with *variolosus*, without the size, mentum, or antennae being mentioned; such as it is the present species differs from it in having the variolose elytral punctures deeper and sparser than on *variolosus*, the small ones on the interstices much sparser and not smaller. One specimen has some of the elliptic ring punctures, adjacent to the suture and the first discal costa, conjoined, so that they are prolonged from three to five times the normal length, without increase in width. Of the eight specimens before me seven have simple front tarsi, and from the other they are missing.

NOVAPUS OBSCURUS, Macl. (formerly ORYCTES).

The type of this species was probably picked up dead; it is opaque and entirely covered with very minute reticulation that may often be seen on beetles that have partially rotted in damp situations; all its tarsi and one antennae are broken. It is a *Novapus*, and structurally is extremely close to the Western Australian *simplex*, but differs in the apex of clypeus, scutellum, and prothoracic excavation.

There are in the Australian Museum two specimens (sexes) from Queensland that probably belong to the species, and are in much better condition; they are both shining, with the punctures more distinct and the minute reticulation absent; the male (from Duaringa) is slightly larger than the type, with the tubercles at the apex of the clypeus rather more prominent, the cephalic horn slightly longer and thicker, and the median carina of the scutellum absent. There is an obtuse swelling at the posterior end of the prothoracic excavation on both the type and the Duaringa males, and I have seen no similar swelling on any other male of the genus.[15] The female (from Eidsvold, and there is an almost identical specimen in the South Australian Museum from Brisbane) in

[15] Since this was written I have seen a male in the National Museum from Cairns.

general appearance is much like the females of *laticollis* and *adelaidae*, but differs from them by the tip of the clypeus being bituberculate as in the male.

By the removal of this species from *Oryctes* that genus must now be expunged from Australian lists, as *barbarossa* has been transferred to *Haploscapanes*, and *mullerianus* to *Pseudoryctes*.

NOVAPUS RUGOSICOLLIS, Blackb.

Pl. xxvii., figs. 88 and 89.

There are numerous specimens of this species in the National Museum from the King River, Northern Territory, all marked as taken from termite mounds. The male, hitherto undescribed (the type was noted as a male, but this was subsequently corrected) in general appearance is very close to the male of *N. bifidus* (the types of which were also taken from termite mounds) but differs in having the cephalic horn much less conspicuously bifid, the extent of the prothoracic excavation is much the same, but its walls are more acutely carinated and in front (but not at the apex) and posteriorly (but not at the base) each carina from some directions appears to terminate as a subconical tubercle; by the males alone, however, it would probably have been considered that *bifidus* was only a varietal form; but the females are very distinct, on *bifidus* the cephalic horn is distinctly bifid; on *rugosicollis* it is briefly conical.

ANEURYSTYPUS CARINATICEPS, n. sp.

Pl. xxvii., fig. 82.

♂. Bright castaneous, some marginal parts narrowly infuscated. Under-surface, legs, base of antennae, and ocular canthi, with long rusty-red hair; elytra with a dense fringe of short pale hair, projecting downwards, and a longer fringe of stiffer redder bristles, projecting outwards, pygidium with a loose fringe of long hairs at the apex, but base glabrous.

Head with fairly dense punctures on a semicircular space behind the clypeus, base with sparse and small ones. Clypeus with semicircular, strongly-elevated margins; punctures larger than on rest of head, its hind suture marked by a strong transverse carina, subangularly elevated in its middle, and curved on each side so as not to touch the margin. Antennae ten-, club three-jointed; club very long and almost parallel-sided. *Prothorax* not twice as wide as long, a narrowly impressed line across front margin; with small scattered punctures, becoming more numerous, but not crowded towards sides in front. *Scutellum* almost impunctate. *Elytra* with a rather deep subsutural stria, elsewhere striation very ill-defined, but the punctures in subgeminate rows.

Pygidium with fairly dense punctures about base, but sparse elsewhere. Front *tibiae* strongly tridentate; claws long, thin, and equal. Length, 14-15 mm.

Hab.—Queensland: Capella (Relton collection). Type in Queensland Museum, cotype, I. 10768, in South Australian Museum.

In general appearance like *inermicollis*, but the clypeus is more semicircular, and the transverse carina is subangularly elevated in the middle; *pachypus* has the clypeus transverse, carina and legs very different; *pilosicollis* is much smaller, head very different, and prothorax conspicuously clothed; *laevis* is much smaller, with the carina not elevated in middle, etc.; the males of all the other described species have the prothorax armed in front. The club of the antennae is distinctly longer than the front tibiae; the elytral punctures are rather small and are rather distantly placed in rows, the gemination of these being very feeble. Under a fairly high power the whole upper-surface and the pygidium appear to be very finely shagreened, and as a result less shining than on other species of the genus. Both specimens appear to have feeble remnants of a wide median line on the prothorax, but these are possibly due to irregular contraction.

Corynophyllus curvicornis, n. sp.

Pl. xxvii., fig. 81.

♂. Bright castaneous, parts of head and tibiae, and margins of prothorax of scutellum and of elytra more or less infuscated. Under-surface, legs, basal joint of antennae, and ocular canthi with long, rusty-red hair, elytra with a rather dense fringe of short pale hair projecting downwards, and a somewhat longer fringe of sparser and darker hairs projecting outwards: pygidium fringed with hairs, at the base rather short and irregular, at the apex longer and regular.

Head with a strong and acute recurved horn between eyes, with sharply-defined but not very large punctures. Clypeus semicircular, margins rather strongly and equally upcurved. Ocular canthi wide, rather flat; with shallow and dense, subasperate punctures. Antennae ten-, club three-jointed; club widely subelliptic-ovate, about as long as width of head at base. *Prothorax* with a wide and deep excavation, front angles acutely produced, the hind ones widely obtuse; with rather small and sparse but sharply-defined punctures, becoming somewhat larger and denser on parts of sides. *Scutellum* impunctate. *Elytra* not much longer than wide; with subgeminate, but more or less irregular rows of fairly large ring punctures, usually in very feeble striae. *Pygidium* with sparse but distinct punctures, becoming crowded and shallow

in corners. Front *tibiae* strongly tridentate; claws long, thin, and equal. Length, 16 mm.

Hab.—Queensland: Maryborough (H. J. Carter from A. Steven). Type (unique), I. 10766.

The raised margin of the clypeus forms an almost true semicircle, as on several species of *Aneurystypus*, more distinctly so than on *C. modestus*, or on a species which is probably *C. metallicola*, with which it would be associated by the simple cephalic horn, but the horn is much longer than on either of those species, and the prothoracic excavation is much larger; the club of the antennae is as long as in *modestus* or *fortnumi*, but not so wide, although less parallel-sided than on the species of *Aneurystypus*. The horn from its base in front is about as long as the head is wide across the eyes, it curves back well over the front margin of the prothorax. The excavation occupies about half the width and about two-thirds the length of the prothorax, at the middle of its hind border it has a short semicircular extension, the front corners of which, from some directions, appear subtuberculate; the front margin is without a median tubercle.

Metanastes bicornis, n. sp.

Pl. xxvii., figs. 83 and 84.

♂. Black, highly polished; parts of appendages obscurely diluted with red.

Head widely excavated and with a few punctures between eyes; with two stout curved horns in front; clypeus quadrisinuate in front. Antennae ten-, club three-jointed. *Prothorax* strongly and evenly convex, sides gently rounded and not much wider at base than at apex; marginal stria narrow, with a small median node near the apex; impunctate. *Elytra* as wide as prothorax, and about twice as long: with rather shallow ring punctures in feeble striae, but about apex rather crowded, an almost impunctate space near each side. *Prosternum* with a strongly elevated, subcylindrical process, crowned with reddish bristles, behind coxae. Front *tibiae* with three strong, and two or three small teeth; front claws unequal. Length, 21-22 mm.

♀. Differs in having the excavation on the head much smaller, the horns reduced to feeble elevations, the small prothoracic node absent, and the front claws equal.

Hab.—New South Wales (J. S. Clark); Queensland: Yandella (F. A. Gore); Brisbane (C. Wild). Type, I.10765.

The fringe at the apex of the hind tibiae is composed of but few short and stout processes (they are too stout to be regarded as setae) but as they are detachable no doubt the hind margin may be regarded as ciliate; this being the case

the species (in an unpublished table by the late Rev. T. Blackburn) could only be referred to *Metanastes.* Excluding the head the general appearance of the species is like a very large *Metanastes australis*, Blackb., and the curious process behind the front coxae is much the same as on that species, but the head is very different, and there are many other slight differences. Of the four specimens before me one has a median line very faintly indicated on the pronotum, two have it just traceable about the base, and from the other it is absent. The front claws of the female are simple; on the male one claw is much thicker than the other and much more curved; on the front tibiae there are two strong teeth, then a small one, then a large one, and then one or two small ones; the pygidium has dense punctures on both sexes, but on the female they are larger and more crowded than on the male, and the female has on it a conspicuous transverse ridge that is barely indicated on the male. The horns on the head of the male are rather more than half the length of the front tibiae on two specimens, but are rather less on the type.

Chlorobapta frontalis, Don.

Pl. xxvii., fig. 90.

There are in the National Museum two males from Kookynie and Norseman, and one in the South Australian Museum from Ankertell, that I cannot satisfy myself are really distinct from *frontalis;* but they differ from the more ordinary forms of that species in having the submedian tooth of the front tibiae much more acute, and the strigae of the pygidium more conspicuous. The markings are of a clear sulphur-yellow, not the dingy shade of yellow that the green markings often turn to with age or improper treatment, and Mr. Horace W. Brown assures me this is the natural colour of living specimens; *frontalis*, however, is such an extremely variable species, that it does not appear desirable to describe these specimens as representing a new species, or even to give them a varietal name.

Diaphonia euclensis, Blackb.

Mr. W. du Boulay has a specimen of this species in which the prothoracic blotch is reduced to a slight infuscation at the apical third.

Anoplognathus prasinus, Cast., formerly Paranonca.[16]

Pl. xxvii., fig. 68.

The history of this species is somewhat complicated: at one time it was regarded as a New Zealand species, and a

(16) Hist. Nat., ii., 1835-40, p. 143.

synonym of *Stethaspis* (now *Chlorochiton) suturalis* of the Melolonthides, but Lansberge, followed by Arrow and Ohaus, referred it to the Rutelides. There are specimens of it in the Museum from the Richmond River (New South Wales) and Caloundra (Queensland); in general appearance it is like a short thick-bodied female of *Stethaspis eucalypti (Xylonychus)*, but it differs in many details of sculpture, and particularly in the metasternum and claws.

ANOPLOGNATHUS SMARAGDINUS, Ohaus.

Calloodes prasinus, Macl.

Pl. xxvii., figs. 69 and 70.

As the front tibiae of *Calloodes prasinus*, Macl., are not unidentate, Ohaus referred the species to *Anoplognathus*, and there being already a *prasinus* in that genus he altered the name to *smaragdinus*.(17)

ANOPLOGNATHUS MULTISERIATUS, n. sp.

Pl. xxv., fig. 36; pl. xxvii., fig. 67.

Of a rather dark olive-green and highly polished; legs reddish with a coppery gloss, tarsi darker, antennae, palpi, and tip of mesosternal projection reddish. Upper-surface glabrous, pygidium uniformly clothed with depressed white hairs or setae, becoming longer and denser on sterna, and sparser along middle of abdomen.

Head rather wide and lightly convex; with small and sparse but sharply-defined punctures near base, becoming larger in front. Clypeus about thrice as wide as long, front margin moderately, the sides lightly upturned; with rather crowded punctures. *Prothorax* about twice as wide as long, front angles subacute, hind ones obtuse, base trisinuate, the median sinus narrower than scutellum; punctures rather small and not very dense, becoming coarse and crowded on sides, with a narrow and scarcely depressed but impunctate median line. *Elytra* slightly wider than prothorax, apex truncate; with crowded rows of large punctures, becoming more regular towards sides. *Pygidium* with crowded punctures transversely arranged. Intercoxal process of *metasternum* long and acute. Front *tibiae* tridentate, apical tooth long and acute, second triangular and rather large, the other obtuse, claws uneven, the larger front one conspicuously bifid at apex. Length, 21 mm.

Hab.—Queensland: Bribie Island (H. Hacker). Type (unique), in Queensland Museum.

A rather small, strongly punctured species, not very close to any other known to me; of the other green species it may be

(17) Stett. Ent. Zeit., 1904, p. 90.

distinguished from *aeneus* (Waterhouse) by its much smaller size, very different clypeus and partly red legs, from *punctulatus* (Olliff) and *prasinus* (Macleay) by the more robust build, much coarser punctures, and very different clypeus, from the species identified by Ohaus as *prasinus* (Castelnau) by the much darker green without pale margins, elytra without regular striae, and by the different punctures and clypeus. From some directions the prothoracic margins and median line, scutellum, and the suture and margins of elytra appear to be of a brighter green than the adjacent parts. There are not distinct discal striae on the elytra, but to the naked eye the punctures appear to be packed together in close rows, about eighteen rows on each elytron, they are frequently transversely conjoined, and there are often strong punctures on the interstices between the rows; they are coarser than on any other species, except *velutinus*, but are not interspersed with foveae as on *porosus* and *olivieri*.

CALLOODES NITIDISSIMUS, n. sp.

Pl. xxvii., figs. 71 and 72.

♂. Bright metallic-green and highly polished; antennae dull red, club darker. Upper-surface glabrous; pygidium evenly clothed with depressed white hairs or setae, these becoming dense on parts of sterna and sides of abdomen, legs sparsely clothed, a row of reddish bristles on front femora.

Head wide, obliquely flattened in front; with sparse and rather small but sharply-defined punctures. Clypeus about twice and one-half as wide as long, front margin rather strongly upturned; punctures distinct only on sides, hind suture feebly sinuous. *Prothorax* about twice as wide as long, gently convex, front angles acute, hind ones almost rectangular, base trisinuate, all margins thickened except close to scutellum and in middle of apex; punctures very small and sparse in middle, becoming larger (but still small) and denser on sides. *Scutellum* with sparse and minute punctures. *Elytra* with outlines continuous with those of prothorax, each elytron subtriangularly produced and finely serrated at inner apex, without discal striae, but with a narrow one on each side and a feeble one near apical half of suture; punctures very small and sparse, towards sides becoming lineate in arrangement. *Pygidium* with dense and fine sublaminate punctures. Front *tibiae* with a strong apical tooth only; claws unequal but simple. Length (♂, ♀), 20-23 mm.

♀. Differs in having a conspicuous brassy gloss, the clypeus considerably wider, less upturned in front, and with larger and denser punctures, the punctures behind its hind suture are also larger and denser, the club of the antennae is

smaller, and there is a very slight projection on the smaller front claw.

Hab.—Queensland: Coen River (Blackburn collection and W. D. Dodd), Claudie River (J. A. Kershaw). Type, I. 1911.

The unidentate front tibiae renders it certain that this species should be referred to *Calloodes*, instead of to *Anoplognathus;* the size and shape are much as those of *atkinsoni*, but the margins of the prothorax and elytra are not purplish, and the clypeus has less strongly upturned margins (these in some lights appear to be diluted with red); *rayneri* has reddish legs, considerably larger, although small punctures, and differs in many other respects. On the male the coppery tinge is scarcely in evidence, but on the females it is very conspicuous, and their elytra in some lights appear to glow fiery-red; the abdomen and front coxae of the only male under examination are partly reddish, but this may be due to immaturity; the sides of the elytra are feebly wrinkled, the production of their apices is not a sexual character; all the specimens have a curious appearance as of being covered with wet varnish.

Repsimus manicatus, Sw.

The form with red prothorax, and hind tibiae in the male greatly dilated to the apex, and more than twice the width of the base, was considered by Ohaus as not the real *manicatus*, but *aeneus* (18): in this he differed from several previous workers, and here I regard that form as *manicatus*.

var. montanus, n. var.

On several of the higher mountains in Victoria, and on Mount Kosciusko in New South Wales, a form occurs whose upper-surface in entirely brassy-green, or with only the sides of the prothorax obscurely diluted with red, but with the red legs and greatly dilated hind tibiae of the preceding form. Seen from behind the whole upper-surface of some specimens appears blackish-purple. The general colour is very similar to that of many small specimens of *purpureipes*, but on that species the hind tibiae of the male are scarcely thicker at the apex than in the middle. Mr. Davey took numerous specimens at Bright, in Victoria.

Schizognathus viridiaeneus, Ohaus.

Pl. xxvii., figs. 74 and 75.

The female of this species was unknown to Ohaus. Two specimens (sexes) were received from Bryon Bay (New South

(18) Stett. Ent. Zeit., 1904, p. 70, pl. i., fig. 8.

Wales); of these the male agrees perfectly with a male bearing Mr. Arrow's identification label as *viridiaeneus*, and with the position assigned to it in the table by Ohaus; the basal joint of its front tarsi is but slightly longer than the second joint (from above it appears to be no longer). The female differs in being more robust, its clypeus red, with its sides almost evenly decreasing in width to apex, which is upturned with the corners rounded off; the front tarsi are thinner, with the basal joint more than twice the length of the second, and the larger claw-joint cleft. By Ohaus's table it would be referred to *lucidus*, of which the female is unknown to me, but the male is very distinct from the male of *viridiaeneus*.

SCHIZOGNATHUS BURMEISTERI, Ohaus.
Pl. xxvii., fig. 73.

This species occurs in Victoria (Gippsland) as well as in New South Wales (Galston) and Queensland.

MIMADORETUS NIVEOSQUAMOSUS, n. sp.
Pl. xxvii., fig. 76.

♀ Dark piceous-brown, with a metallic-green gloss; elytra, antennae, palpi, and most of legs more or less castaneous. Moderately clothed with thin, white, depressed scales or setae, becoming dense on pygidium and under-surface.

Head with large, sharply-defined punctures, rather dense near clypeal suture, smaller and sparser near base. Clypeus transversely oblong, about thrice as wide as long, margins moderately upcurved; with crowded, asperate punctures. Antennae ten-, club three-jointed. *Prothorax* scarcely twice as wide as long, sides rather strongly rounded, front angles produced and subacute, hind ones subrectangular; middle with rather sparse and small but sharply-defined punctures, becoming larger and denser on sides. *Scutellum* with a few submarginal punctures. *Elytra* gently dilated to beyond the middle, each widely separately rounded at apex; each with thirteen well-defined striae, containing distinct punctures, interstices smooth and almost impunctate. *Pygidium* with dense but normally concealed punctures. *Prosternum* with a conspicuous elevation at base, produced to between middle of front coxae. Mesosternum with a triangular process, not passing middle of coxae. Front *tibiae* strongly bidentate; basal joint of front tarsi as long as the three following combined, larger claw-joint cleft at apex. Length, 12-14 mm.

Hab.—Queensland: South Johnstone River (H. W. Brown). Type, I. 10769.

The greenish gloss is very conspicuous on the scutellum and margins of prothorax. The scales on the elytra are almost

confined to the sides of the striae, on the prothorax of one specimen they are fairly evenly distributed, but they are almost absent (no doubt from abrasion) from the median third of another. I have not been able to see the front of the lower lip clearly, but it appears to be obtusely pointed in the middle, in this respect differing from the typical species, *flavomaculatus;* but the ten-jointed antennae, shape of clypeus, processes between front and middle coxae, bidentate front tibiae, and larger front claw cleft in the female, with the scaly body, indicate that it is either a *Mimadoretus* or extremely close to that genus.

MIMADORETUS LEUCOTHYREUS, n. sp.

Pl. xxvii., fig. 77.

♂. Of a rather dark castaneous; antennae, palpi, and parts of legs paler. Somewhat irregularly clothed with white hairs.

Head rather convex; with dense and moderately large punctures, becoming smaller and sharply defined about base. Clypeus transversely suboblong, about twice as wide as long, front margin gently incurved to middle and moderately upturned, sides very feebly upturned; punctures much the same in front of, as behind the suture. Antennae ten-, club three-jointed; club as long as clypeus is wide. *Prothorax* rather strongly convex, about once and one-half as wide as long, sides subangularly dilated in middle, front angles subacute, hind ones obtuse; with moderately large and fairly numerous punctures in middle, becoming denser and larger on sides. *Scutellum* with dense, concealed punctures. *Elytra* slightly wider than prothorax, apex almost truncate; each with thirteen rather deep and regular striae containing punctures, these rather large at base, sides, and apex, but mostly smaller elsewhere; interstices almost impunctate. *Pygidium* with crowded, partially concealed punctures. *Prosternum* with a narrow wedge-shaped process extending to between coxae. Mesosternum with a triangular process between coxae. Front *tibiae* tridentate, apical tooth long, curved, and acute, second triangular and rather large, third feeble; basal joint of front tarsi slightly longer than second, claws long, thin, and unequal, but simple. Length, 11 mm.

Hab.—Queensland: Cairns district (A. M. Lea). Type, I. 4853.

Two specimens were obtained, on one of which there is a vague greenish gloss on part of the prothorax. The upper portion of the head is almost glabrous; on the prothorax there are numerous subdepressed hairs on the sides, but the median third is almost glabrous, the scutellum is densely clothed, on

the elytra the hairs are fairly numerous, but mostly arise from the sides of the striae, on the margins they are denser, on the pygidium the depressed hairs are rather less dense than on the scutellum, and there is a marginal fringe of long ones; on the under-surface and legs the hairs are long, rather dense and erect. The humeral callosities are almost impunctate. The feebly incurved apex of lower lip, ten-jointed antennae, processes between front and middle coxae and clothed (although not scaly) body, indicate that this species also belongs to *Mimadoretus* or is extremely close to it, despite the tridentate front tibiae, of which, however, the tooth nearest the base is due more to the emargination between it and the second one, than to a projecting part of the tibia itself; they certainly do not belong to *Mimela*. On the present species the two joints before the club are so close together that from some directions the antennae appear to be composed of but nine joints.

ADORETUS, Cast., Hist. Nat. Col., ii., p. 142;
Lacord., iii., p. 380.

This genus apparently has not been previously recorded from Australia, it may be readily distinguished from all other Australian genera of Rutelides by the labrum being produced in a curved process, usually with crenulated sides, over the labrum. The general appearance of the species described below is like some *Melolonthides* allied to *Heteronyx* with unusually large eyes.

ADORETUS MELVILLENSIS, n. sp.
Pl. xxvii., fig. 78.

♂. Smoky-brown, head darker between eyes, parts of elytra, and most of legs and antennae somewhat flavous. Evenly but not very densely clothed with depressed whitish pubescence, becoming longer on pygidium, parts of under-surface and legs; a dense and somewhat golden fringe on clypeus.

Head wide and moderately convex; with rather dense, shallow, and frequently transversely-confluent punctures. Clypeus semicircular, margins strongly elevated; punctures subgranulate, and more sharply defined than on rest of head. Eyes very large. Labrum with numerous, small acute granules, sides of its produced part black and crenulate. *Prothorax* more than thrice as wide as long, sides gently rounded and finely serrated; punctures much as on head between eyes. *Elytra* very little wider than prothorax, each with four discal costae, the first and second extending from base to near apex, the third shorter, the fourth (near the margin) still shorter, punctures of moderate size but shallow,

almost regular close to the costae, irregular elsewhere. *Pygidium* with dense asperate punctures. Front *tibiae* strongly tridentate, the teeth black-tipped and close together, basal joint of front tarsi about as long as two following combined, claws long, simple, and unequal. Length, 11 mm.

Hab.—Northern Territory: Melville Island (W. D. Dodd). Type (unique), I. 4854.

The hairs composing the fringe on the clypeus are all depressed and directed backwards. All the elevated parts of the elytra are distinctly paler than the depressed parts.

Since the above was written I have examined some specimens from the King and Roper Rivers in the National Museum; these vary in length from 10 to 12 mm., and in colour from that of the type to having the upper-surface (the shoulders and subapical callosities excepted) black; two are females and have the larger of the front claws slightly cleft, their colour varies as in the males and the clypeal fringe is much the same.

Saulostomus mimicus, n. sp.

Pl. xxvii., figs. 79 and 80.

♂. Bright castaneous, tibial teeth and some marginal parts darker. Under-surface, legs, base of antennae, and ocular canthi, with long, rusty-red hair, pygidium with depressed but long pubescence, and with long straggling hairs, elytra fringed with reddish setae, directed outwards, and with a thin membrane directed downwards.

Head with sharply-defined and rather sparse punctures about base, becoming rather dense in front, and crowded but less sharply defined on clypeus. Clypeus semicircular, margin moderately upturned in front, less so on sides, hind suture slightly arched, the convex side directed to the front. Antennae ten-, club three-jointed; club long, almost parallel-sided, distinctly longer than front tibiae. *Prothorax* about thrice as wide as long, sides rather strongly and evenly rounded, not much wider at base than at apex, front angles subacute, hind ones rounded off, all margins narrowly impressed except in middle of base; punctures of moderate size, sharply impressed and nowhere dense, even on sides, interspersed with numerous minute ones. *Scutellum* with two kinds of punctures as on prothorax. *Elytra* with conspicuous, but irregular geminate rows of fairly large punctures, in moderate or feeble striae, the interstices also with rather large punctures, numerous small punctures scattered about. *Pygidium* with dense and rather shallow transverse punctures. Front *tibiae* strongly and acutely tridentate; claws unequal but simple. Length (♂, ♀), 13-16 mm.

♀. Differs in being more robust, head with crowded punctures except at extreme base, where only are they individually distinct, clypeus more transverse, club of antennae less parallel-sided and only about two-thirds of the length of front tibiae, prothorax with larger and more numerous punctures, and the larger claw of the front tarsi conspicuously cleft at apex.

Hab.—Queensland: Cunnamulla (H. Hardcastle).

Close to *S. collaris*, and like that species in general appearance strikingly resembling several species of *Aneurystypus*, (to which genus *collaris* was originally referred by Blackburn), but the male differs in being consistently larger and with different punctures on the head; on the present species the punctures from the clypeal suture to the base are all sharply defined, and non-confluent; on *collaris* they are crowded and confluent behind the suture, but become isolated towards the base, the differences being pronounced between five males of each species; there are other slight differences of the antennae and legs. In general appearance and structurally it is close to *S. weiskei*, but without the least metallic gloss, the prothorax smaller and with larger punctures, those on the head larger and clypeus less strongly narrowed in front. From *S. villosus* it is distinguished by its glabrous upper-surface and from the description of *S. felschei* by its very different colour. Mr. Hardcastle obtained numerous males at lights, but only one female.

DASCILLIDAE.

Macrohelodes.

The species of this genus are usually very variable in colour, and to a certain extent in size; Tasmanian specimens are also usually larger, and frequently darker than mainland ones of the same species.

Macrohelodes lucidus, Blackb.

The type of this species was described as having the upper-surface black, except for the narrowly reddish suture of elytra. Of two cotypes in the Museum one is of a very dark brown, with a slight bluish gloss, and the suture somewhat paler, but the second specimen is paler. Other specimens vary from a rather bright-castaneous to almost black, with the suture uniform in colour with the rest of the upper-surface. The species may be readily distinguished from all others by its polished and almost impunctate elytra, and by a small marginal fovea at the basal third of each elytron (not mentioned in the original descriptions). It occurs from Nelson, in Victoria, to Stradbroke Island, in Queensland.

MACROHELODES PRINCEPS, Blackb.

I have seen no specimen agreeing with the description of this species, the type of which is now in the British Museum; should it prove to belong to the same species as *crassus*, it has precedence over that name.

MACROHELODES CRASSUS, Blackb.
var. *intricatus*, Blackb.
var. *gravis*, Blackb.
var. *tasmanicus*, Blackb.
var. *niger*, Lea.

This appears to be the most variable Australian species of the family, as it ranges from specimens having the upper-surface entirely pale, to those having it entirely black, and

where markings are present these are often asymmetrical; in size it ranges from 6·5 to 10 mm., the average of New South Wales specimens being about 7, those of Tasmania about 9. Two specimens from the Blue Mountains (figs. A and B) were standing in the Blackburn collection as *crassus*; two from Blackheath (figs. C and D) differ in having the median spot or fascia broken up into two, and one (fig. C) has the subapical spot broken up into two. A small specimen from Ebor (fig. E) has the humeral spot greatly reduced in size, and one (fig. F) from New South Wales, and another from the Endeavour River, have the markings (except the humeral

one) absent. Tasmanian specimens frequently have the dark elytral markings, except the humeral ones, all conjoined (as in fig. G), or even extended (as in fig. H), with all conjoined, only rarely are they as in fig. I; in fig. J is shown a form in which the markings are irregularly broken up but black, on many specimens, however, the markings are broken up into indeterminate brown specks and blotches, which gradually become fainter till the elytra are entirely pale. In fig K the markings are reduced to three clusters, and there are many specimens with other markings before me. Although I have only given patterns of the elytra it is to be noted that the prothoracic markings are also very variable; in the patterns the elytra are drawn somewhat obliquely from the sides, this causing the scutellar notch to appear smaller than it really is, and the suture to appear somewhat curved.

intricatus, Blackb. Blackburn thought this form was possibly a variety of *crassus*, and this I think is the case: of three specimens standing in his collection one has markings approaching those of fig. J, but less sharply defined, usually on the variety only the humeral spot (as in fig. F), is left, and not always that.

gravis, Blackb. This is an entirely pale form, which Blackburn considered distinct by its colour, by the obsoletely costate elytra and by the punctures. Although many specimens appear to have each elytron obsoletely tricostate, this appearance is really due to three vague longitudinal pale stripes on each; the punctures are subject to a certain amount of variation, but their apparent size is considerably altered by waterlogging (as on many specimens of *Cordus hospes*): their real size may be noticed by looking at them obliquely.

tasmanicus, Blackb. This is a fairly common form in Tasmania. I cannot follow Blackburn in regarding its antennae as essentially different from those of *crassus*; comparing New South Wales and Tasmanian specimens side by side with antennae *in the same position*, no such differences as he denotes are distinct, but comparing a specimen with antennae gummed to the card, and one with them free apparent differences may be seen, this being partly due to matting of pubescence.

niger, Lea. This is the extreme form on the dark side, as *gravis* is on the pale side. The type was from King Island, but there are specimens in the Museum from Flinders Island and Tasmania (George Town and Sheffield).

Macrohelodes montanus, n. sp.

Head black; prothorax reddish, lateral and apical margins paler, base narrowly infuscated; elytra of a dingy

flavo-testaceous, sides paler, shoulders and suture black or infuscated; mesosternum, metasternum, and part of abdomen black or blackish, rest of abdomen of a dingy red; legs reddish, parts of tarsi infuscated. Under-surface and legs densely and finely pubescent, upper-surface glabrous.

Head with crowded and sharply-defined punctures, a shallow depression near each eye. Antennae extending to hind coxae, second joint shorter than third, their combined length about equal to fourth. *Prothorax* more than thrice as wide as the median length; with crowded punctures, slightly larger than on head, and much as on scutellum. *Elytra* not much wider than prothorax, but about six times its length; with crowded punctures not quite as dense, but larger than on prothorax. *Under-surface* with dense and minute punctures. *Tibiae* finely spurred at apex. Length, 4·5-6 mm.

Hab.—Tasmania: Mount Wellington, including the summit (Aug. Simson and A. M. Lea), Cradle Mountain (H. J. Carter and Lea), Devonport (Simson), Magnet (O. L. Adams). Type, I. 10686.

An elliptic species, readily distinguished from all others of the genus by its consistently smaller size, more depressed form, and much denser punctures, notably of the pronotum. The colour of the majority of the specimens under examination is as above noted, but the prothorax sometimes has two, four, or more infuscated spots, the scutellum is usually black, the dark spot on each shoulder may be sharply defined and small, or less defined and continued as a vague stripe to well beyond the middle, on such specimens the pale sides are very conspicuous, the sutural infuscation is usually very narrow. One specimen, from Magnet, has the prothorax black, except for the narrowly pale sides and apex, the dark humeral marking is continued almost to the apex, but beyond the middle breaks up into a series of infuscate spots, and there are numerous other feeble spots on the disk. Another specimen, from Mount Wellington, has the prothorax red, with pale margins and a few indeterminate dark spots about the base; its elytra are black, except for a narrow flavous stripe on each side, and a small transverse flavous spot, between the scutellum and each shoulder.

Sclerocyphon maculatus, Blackb.

The markings of this species (which occurs from the Alpine district of Victoria to Cairns in North Queensland, although apparently nowhere common) vary considerably, but on the prothorax the sides are usually flavous, with the median third blackish.

Sclerocyphon basicollis, Lea.

Two specimens from North Queensland (Blackburn collection), and Toowoomba (Queensland Museum), differ from the type in having the pale pubescence on the pronotum extended so as to cover the base with the exception of three spots, which by contrast with the rest of the surface appear black. The Toowoomba specimen has the elytra of a dingy red, irregularly mottled with brown.

Sclerocyphon aquaticus, n. sp.

Black; extreme margins of prothorax and of elytra, and parts of legs obscurely reddish. Upper-surface irregularly clothed with ashen pubescence, under-surface densely and uniformly clothed.

Head gently convex in middle; with small, dense, almost concealed punctures. Antennae not extending to middle coxae, third joint scarcely longer than fourth, but conspicuously longer than second. *Prothorax* about thrice as wide as the median length, sides curved, thin, and much wider at base than at apex, front rather deeply emarginate for reception of head, median line feebly defined in front, distinct on basal half, with a small, shallow, transverse impression on each side of middle, and several elsewhere: punctures dense and minute. *Elytra* at base the width of prothorax, sides gently dilated to beyond the middle, and narrowly margined, at about the basal third with a fairly large but very shallow marginal depression; punctures as on prothorax. Length, 6-7 mm.

Hab.—Tasmania: Waratah (H. J. Carter and A. M. Lea). Type, I. 10687.

In searching for Parnidae at Waratah Mr. Carter pulled out a log from the water and obtained a specimen of this species from an immersed part of it; a few minutes afterwards I obtained two more in the same way. The clothing of their upper-surface has a somewhat spotted appearance, as if the derm had been irregularly abraded, although I am satisfied they are in perfect condition; the type has an appearance as of having a feeble median fascia, on a second specimen (returned to Mr. Carter) this appearance is less defined; on the third most of the clothing is blackish, but there are several distinct pale spots, and beneath these the derm itself is reddish, there being quite a conspicuous angular spot about the middle of each elytron. The general outlines are briefly elliptic; the junction of the prothorax with the scutellum and elytra is very finely serrated; the elytra in parts about the suture are very finely transversely wrinkled.

Two specimens from Hobart (A. M. Lea) agree in structure with the type, but have the elytra reddish, with many infuscated spots or blotches, and these, with the pale patches of clothing, give them a curiously speckled appearance; the prothorax has the sides rather widely diluted with red; the under-surface is reddish, except for the metasternum and for three black spots on each of the second to fourth segments of abdomen. A specimen from Brighton (Simson's collection) may also belong to the species, but is of an almost uniform rusty-brown colour, with the pubescence on the upper-surface scarcely variegated; the median line of its prothorax is less distinct than on the type, and the two small submedian transverse impressions are just traceable. A specimen from the Tasmanian Lakes (Blackburn's collection) in colour is very similar to one of the Hobart specimens, but the prothoracic impressions are even less distinct than on the one from Brighton. Looking at these specimens from a distance the elytra of each of the seven appear to have two thin and more or less vague pale fasciae: one about the middle, the other half-way between the first and the apex.

MALACODERMIDAE.

Carphurus myrmecophilus, n. sp.

♂. Red; elytra (suture excepted), mesosternum, metasternum, and parts of abdomen and of legs more or less deeply infuscated. With numerous long, straggling, dark hairs, more numerous on elytra and abdomen than elsewhere.

Head with two feeble longitudinal depressions between eyes, bounded by obscure ridges, the latter transversely conjoined behind eyes; with fairly dense but somewhat irregular punctures. Eyes rather small, but lateral and prominent. Antennae extending to about middle of elytra, first joint moderately stout, about as long as second and third combined, second subglolular but slightly wider than long, third slightly wider and larger, third-tenth subequal in length, fourth-tenth conspicuously wider than long, each joined to the middle of the preceding one by a thin stalk, eleventh distinctly longer than tenth, its tip bilobed. *Prothorax* slightly wider than long, sides evenly rounded, base depressed; almost impunctate. *Elytra* not much longer than their greatest width, which is just beyond the middle: with numerous shallow punctures and feeble granules. *Legs* moderately long, basal joint of front tarsi with a narrow black rim at outer apex. Length, 4·50-5 mm.

Hab.—South Australia: Lucindale, several specimens from a nest of *Iridomyrmex detectus* (B. A. Feuerheerdt). Type, I. 10680.

The elytra on one of the specimens are almost black, with a slight bluish gloss; the apical segment of the abdomen is entirely pale, the others have the sides and tips pale; the four hind femora are more or less deeply infuscated, and the infuscation sometimes extends to other parts of the legs. The elytra from some directions appear to be feebly wrinkled, the punctures and granules are not very sharply defined, although sufficiently distinct. The female (not taken by Mr. Feuerheerdt) will probably be found to have the head smooth and the basal joint of the front tarsi simple.

The generic distinctions between *Carphurus*, *Helcogaster*, and *Neocarphurus* are comparatively trifling, but still with long series of each seem quite satisfactory, and they may be readily separated at a glance; but the present species, except for the antennae, seems intermediate between *Carphurus* and *Helcogaster;* the fourth-tenth joints of its antennae, however, are conspicuously wider than long (not due to serrations or rami), this being at variance with all other brachelytrous Malacodermidae with exsertile vesicles. The species should perhaps have been regarded as the type of a new genus.

PTINIDAE.

Enasiba tristis, Oll.

Pl. xxv., figs. 37 and 38.

Mr. Clark has taken, near the Swan River, several specimens of this species from nests of the twig-mound ant *(Iridomyrmex conifera)*. They vary in length from 3·5 to 4 mm., and in colour from piceous to deep shining black, with the legs more or less reddish. They all have four small short yellow fasciae on the subbasal impression of the prothorax: two marking the end of the median line, and one on each side. The antennae are peculiar, and from the side (pl. xxv., fig. 38) agree with Olliff's description, but from above they look very different (fig. 37).

Enasiba tristis, Oll.

Polyplocotes carinaticeps, n. sp.

Pl. xxv., fig. 39.

Castaneous, elytra, abdomen, and tip of antennae somewhat paler than other parts. Glabrous.

Head opaque, and with dense punctures; with a narrow median line from antennae to base, from antennae to lip with a strongly elevated narrow ridge. Antennae rather short, first joint stout, second rather short, its base partly concealed by apex of first, third to seventh submoniliform, eighth and ninth indistinctly separated, at the base slightly wider than seventh, the tip truncated. *Prothorax* about as long as wide, with a large deep excavation on basal two-thirds, an impression connecting the fovea with each side, a strong acute tooth on each side near apex, with dense (sometimes punctate) striae, mostly converging to the excavation. *Elytra* subovate, base truncate and very little wider than prothorax; with regular rows of distinct and rather small punctures. *Mesosternum* with a narrow intercoxal process extending on to metasternum. *Legs* rather long and thin. Length, 1·5 mm.

Hab.—Western Australia: Swan River, eight specimens from nests of ants, *Cremastogaster conifera* (J. S. Clark).

The strong frontal crest has a rounded outline; the lower cheeks are each greatly expanded as a thin flange. The antennae at first appear to be composed of but eight joints, as the two apical ones are so close together that it is difficult to see the dividing line; on examining the under-surface of the basal joints under a compound power there appears to be a minute joint at the base of the apparent second, but it may not be a true joint. The lateral tooth on each side of the prothorax is nearer the apex than is usual in the allied genera, and in addition there is a very small process on each side at the exact middle. The abdomen of both specimens is widely depressed (probably a masculine feature), its first segment is very short and indistinctly separated from the metasternum, the second is large, its sutures with the first and third indistinct across the middle, but distinct at the sides (as a result, along the middle, the abdomen at first glance appears to be composed of but three segments), the third and fifth are much shorter, and the fourth still shorter. There is some special golden pubescence on the prosternum, but it does not extend to the metasternum or abdomen.

This species might have been regarded as belonging to a new genus, but if true inquilines were to be treated as ordinary Coleoptera, it would be necessary to propose almost as many genera as there are species.

Polyplocotes scabricollis, Lea.

By the favour of Mr. G. F. Hill the type and only known specimen of this species is now in the South Australian Museum.

Diphobia longicornis, n. sp.

Pl. xxv., fig. 40.

Castaneous, head and prothorax somewhat darker than other parts. Upper-surface with sparse and short, semierect setae.

Head with small dense punctures; with a shallow median line. Antennae long and thin, first joint rather stout, second with its base curved under apex of first, third distinctly longer than fourth, fifth-tenth moniliform, eleventh cylindrical, about as long as three preceding combined. *Prothorax* distinctly longer than wide, with a deep post-median transverse impression, marked at its middle by a deep fovea and towards each side by a smaller one; densely strigose. *Elytra* ovate, strongly convex, base truncate, not much wider than prothorax, and with six small deep foveae; with rows of small punctures, the interstices also punctate. *Metasternum* shining, and with fairly large, asperate punctures. *Abdomen* with small punctures in middle of two basal segments, becoming larger and asperate at sides, and on the whole of the third segment. *Legs* long and thin. Length, 1·75-2·25 mm.

Hab.—Western Australia: Swan River, five specimens from nests of the twig-mound ant, *Iridomyrmex* sp. (J. S. Clark). Type, I. 10653.

Readily distinguished from all other species of the genus by the long terminal joint of the antennae. The sterna and abdomen are glabrous. The femora are grooved throughout their length, on the under-surface, for the reception of the tibiae.

Ectrephes formicarum, Pasc.

Pl. xxv., figs. 41 and 42.

Mr. Clark has taken this species, about the Swan River, in abundance from nests of *Iridomyrmex conifera*, and one specimen from a nest of the green-head ant (*Ectatomma metallicum*). These vary in length from 1·25 to 2·25 mm. Of the clothing Pascoe says "elytris . . . pilis minutis erectis valde dispersis." King (of its synonym *Anapestus kreusleri*) says "sub lente setosus." The clothing seems to be particularly liable to abrasion as most of the specimens before me are almost or quite glabrous on the upper-surface; on one specimen there were numerous fairly long hairs on the prothorax and elytra, but on floating it off for examination most of the hairs were lost; on three specimens there are still a few hairs left on the upper-surface. The antennae look very different from different points of view.

Diplocotes foveicollis, Oll.

Mr. Clark has taken four specimens of this species, about the Swan River, associated with the preceding species. Two of them have the elytra considerably darker than in Victorian specimens.

TENEBRIONIDAE.

Alphitophagus bifasciatus, Say.

A. pictus, Menetr.

A. populi, Redt.

A. quadripustulatus, Steph.

This species has been seen in countless thousands in wheat stacks at North Geelong, although it has apparently not been previously recorded from Australia. For references, etc., see Junk, Col., Cat., Pars. 28, p. 382; where it is recorded as from Europe and North America; but it is probably almost world-wide in distribution.

Latheticus oryzae, Waterh.

This species has been taken at wheat stacks in New South Wales (Barellan and Enfield); it does not appear to have been previously recorded as Australia. For references see Junk, *l.c.*, p. 393.

Thorictosoma, n.g.

Head wide, bilobed in front, the lobes partially overhanging antennae. Eyes apparently absent. Mandibles short, stout, notched at tips. Mentum large, convex, concealing labial palpi. Two joints of maxillary palpi exposed, short and subequal. Antennae short, with a closely-compacted three-jointed club. *Prothorax* transverse, front angles produced, hind ones obtuse. *Scutellum* absent. *Elytra* rather short, conjointly rounded at apex, and slightly arcuate at base; epipleurae rather narrow and terminated before apex. *Prosternum* with an obtuse intercoxal ridge, each front angle foveate. Metasternum about as long as two basal segments of abdomen; episterna rather wide, but with indistinct sutures. *Abdomen* with first segment once and one-half the length of second, and the length of fifth, third slightly shorter than second and longer than fourth. *Legs* short; front coxae lightly separated, the middle ones more widely, the hind ones still more widely; femora unarmed, tibiae spinose near base, the front pair dilated, with a strong tooth near base separated from one near apex by a deep notch; tarsi thin, hind ones four-jointed, the others five-jointed; claws small and simple. Apterous.

In general appearance the two species described below are strikingly like several species of *Thorictus* of the Clavicornes: but the tarsi are heteromerous, tibiae very different, and prosternum without pads of clothing. I carefully examined the type of each species both from above and below without seeing eyes, and then decapitated them and examined the heads under the microscope from many angles still without seeing any, so presume both species to be blind. Most of the surface under a fairly high power of the microscope appears to be very finely granulate or shagreened, and in certain lights this causes some parts to have a deceptive resemblance to eyes, but when viewed at a right angle this resemblance vanishes. The clypeus and labrum appear to be absent, as there are no sutures defining their margins. The mentum is large and convex, concealing the labial palpi; of the maxillary palpi only the two apical joints (these fairly stout and subequal) are visible. The antennae are eleven-jointed, but the joints are so close together and even in width at their junctions that it is only under a fairly high power that they can be counted; the three basal joints are concealed from above, the three apical ones form a closely compacted club. The fovea on each of the front angles of the prosternum is closed externally, but open internally, it is evidently for the reception of the club of the antennae, the basal portion of which is received, when at rest, within a groove (bounded internally by a strong ridge) on the lower part of the head. Both species are gently convex with oblong-elliptic outlines. The parts of the mouth of inquilines are usually so greatly modified from species living normal lives, that I do not regard the great modifications of these as excluding the genus from the *Tenebrionidae*. In catalogues it may be placed near *Typhluloma*, the only other known blind genus of the family, but it differs from it in many particulars of the head, antennae, and legs, in some respects it appears to approach *Brachycilibe* and *Platycilibe*, and with the fossorial front legs of *Caedius*, *Caediomorpha*, etc. Type of genus, *ectatommae*.

Thorictosoma ectatommae, n. sp.

Dark castaneous-brown, legs and antennae somewhat paler. Glabrous.

Head gently convex, with two vague oblique depressions in front; punctures dense and sharply defined but rather small. *Prothorax* about once and one-third as wide as long, front angles lightly produced but not clasping sides of head, hind ones not quite rectangular; punctures much as on head, but becoming more crowded on sides. *Elytra* about the width

of prothorax, with a deep marginal stria from base almost to apex; punctures almost even throughout, and slightly denser than on middle of prothorax. *Under-surface* with fairly dense, small, sharply-defined punctures, becoming larger and more crowded on parts of prosternum. Front *tibiae* with a subtriangular tooth near base, separated by a semicircular notch from a larger and more obtuse one at apex; apex with three processes: an acute and rather short spine at inner apex, an obtuse somewhat curved one close to and almost the length of tarsi, and a subacute and somewhat shorter one between it and the short one. Length, 1·9 mm.

Hab.—Western Australia: Swan River, from a nest of a large dark species of *Ectatomma* (J. S. Clark). Type, I. 10681.

One of the most interesting of the many interesting inquilines recently taken by Mr. Clark.

Thorictosoma tibiale, n. sp.

Pl. xxv., fig. 43.

Castaneous-brown. Glabrous.

Head much as in preceding species. *Prothorax* about once and one-half as wide as long, almost semicircularly emarginate in front for reception of head, with a distinct stria from base to apex on each side; punctures small, sharply defined, and almost uniform throughout. *Elytra* about twice the median length of prothorax, and almost its exact width at base; with a narrow deep stria on each side from base to apex, and with extremely vague indications of other striae; punctures much as on prothorax. *Under-surface* with somewhat larger punctures than on upper-surface. Front *tibiae* much as in preceding species, except that there is an additional small process at apex. Length, 2-2·25 mm.

Hab.—Western Australia: Geraldton (A. M. Lea).

In general appearance fairly close to the preceding species, but more uniformly coloured, prothorax rather more deeply emarginate in front, with a stria close to each side (there are none on that species), the marginal stria on each elytron deeper, and two conjoined at apex, with vague indications of other striae, and the front tibiae with an additional process at apex. Of the processes on the front tibiae one is short and acute, one is about the length of the three basal joints of tarsi, one is slightly longer, and the other is longer than the four basal joints combined, somewhat curved and rather blunt. Two specimens, one of which is now headless, were taken in 1896, probably from a nest of ants.

CERAMBYCIDAE.

Parandra frenchi, Blackb.

Pl. xxvii., figs. 91 and 92.

Several specimens of this species have been taken in the Dorrigo district by Mr. W. Heron, and on the Tweed River by Mr. Horace W. Brown. The male differs from the female in having the head considerably wider (its width across the eyes is equal to or slightly exceeds the greatest width of the prothorax, in the female it is distinctly narrower than the apex of the prothorax, and this, in the female, is less than the median width) with larger jaws, antennae longer, with the apical joint decidedly longer, prothorax more narrowed to the base, with the hind angles more acute and the elytra much shorter (only about two-thirds the length) and less parallel-sided. The reference given by Blackburn was misprinted 1885, instead of 1855.

Photographs of Plates XXVI. and XXVII. by H. M. Hale.
Photomicrographs in text by H. Hacker.

EXPLANATION OF PLATES.

Plate XXV.

Fig. 1. ... ... *Leanymus mirus*, Lea, front leg.
,, 2. ... ... ,, ,, ,, hind leg.
,, 3. ... ... ,, ,, ,, armature of metasternum.
,, 4. ... ... *Articerus subcylindricornis*, Lea, antenna.
,, 5. ... ... ,, *wilsoni*, Lea, antenna.
,, 6. ... ... ,, ,, ,, middle leg.
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,, 9 to 11. ,, *duboulayi*, Waterh., views of antenna.
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,, 14. ... ... *Chlamydopsis latipes*, Lea.
,, 15. ... ... ,, *striatipennis*, Lea.
,, 16. ... ... *Euclarkia costata*, Lea, antenna.
,, 17. ... ... *Bolboceras quadriforcatum*, Lea, front view of clypeus.
,, 18. ... ... ,, *bispinicolle*, Lea, front view of clypeus of male.
,, 19. ... ... ,, ,, ,, front view of clypeus of female.
,, 20. ... ... ,, *triunum*, Lea, front view of clypeus.
,, 21. ... ... *Rhopaea decipiens*, Lea, antenna.
,, 22. ... ... ,, *nigricollis*, Lea, antenna.
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,, 39.... ... *Polyplocotes carinaticeps*, Lea, antenna.
,, 40.... ... *Diphobia longicornis*, Lea, antenna.
,, 41 and 42. *Ectrephes formicarum*, Pasc., views of antenna.
,, 43.... ... *Thorictosoma tibiale*, Lea.

PLATE XXVI.

Fig. 44.... ... *Bolboceras quadrifoveatum*, Lea.
,, 45 and 46. ,, *bispinicolle*, Lea.
,, 47 ... ... ,, *triunum*, Lea.
,, 48.... ... *Rhopaea decipiens*, Lea.
,, 49.... ... ,, *nigricollis*, Lea.
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PLATE XXVII.

Fig. 67.... ... *Anoplognathus multiseriatus*, Lea.
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Australian Fungi: Notes and Descriptions. No. 3.

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[Read September 11, 1919.]

Plates XXVIII. and XXIX.

The following paper is a continuation of our two previous ones in this series, and contains a number of notes on, and records of, the larger Australian fungi. The serial numbers are for future reference to the species concerned. The references under "colour tints noted" are to the plates in Henri Dauthenay's "Répertoire de Couleurs . . . ," unless Ridgway's "Colour Standards and Colour Nomenclature" is specifically mentioned.

We would once more emphasize the difficulty attendant on the identification of the fleshy agarics. When referring these to known species, we have in most cases given our description of the Australian plants so determined, so that if we are in error, the mistake can later be rectified.

We would again express our gratitude for being enabled to reproduce coloured plates of most of the new species described, and would offer our congratulations to our artist, Miss Phyllis Clarke, of Chatswood, Sydney, for her admirable delineations of these. We also owe much to the kindness of Mr. C. G. Lloyd, of Cincinatti, for identifying for us so many polypores and other more permanent species. Without his help, our task in these groups would have been very heavy, and errors doubtless numerous. Miss E. Wakefield, of Kew Gardens, has also kindly helped us on several occasions, whilst we are indebted to various Australian friends, whose assistance is acknowledged in the text, for a number of specimens.

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Mycena: 131—*M. banksiae*, n. sp. 132—*M. coccineus*, n. sp. 133—*M. sanguinolenta*, Alb. and Schw.

Pleurotus: 134—*P. lampas*, Berk. 135—*P. ostreatus*, Jacq. 136—*P. subostreatus*, n. sp. 137—*P. Cheelii*, Mass. 138—*P. striatulus*, Fr.

Lentinus: 139—*L. tuber-regium*, Rumph. 140—*L. strigosus*, Fr. 141—*L. dealbatus*, Fr. 142—*L. fasciatus*, Fr. 143—*L. radicatus*, Cooke and Mass. 144—*L. ursinus*, Fr.

Panus: 145—*P. stypticus*, Fr. 146—*P. viscidulus*, B. and Br.

Xerotus: 147—*X. fuliginosus*.

Lenzites: 148—*L. abietina*, Fr. 149—*L. unguliformis*, Berk. 150—*L. striata*, Swartz. 151—*L. saepiaria*, Fr. 152—*L. Beckleri*, Berk. 153—*L. repanda*, Mont. 154—*L. Muelleri*, Berk. 155—*L. bicolor*.

POLYPORACEAE.

Boletus: 156—*B. romanus*, Ottav. 157—*B. scarlatinus*, n. sp.

Strobilomyces: 158—*S. pallescens*, Cooke and Mass. 159—*S. floccopus*, Rost.

Polystictus: 160—*P. elongatus*, Berk. 161—*P. meleagris*, Berk. 162—*P. badius*, Berk. 163—*P. ochraceo-stuppeus*, Lloyd. 164—*P. occidentalis*, Klotzsch. 165—*P. (Trametes) Persoonii*, Mont. 166—*P. subfulvus*, Berk. 167—*P. flavus*, Klotz. 168—*P. versicolor*, L. 169—*P. sanguineus*, L. 170—*P. cinnabarinus*, Jacq. 171—*P. cervino-gilvus*, Jungh.

Polyporus: 172—*P. Clemensiae*, Murr. 173—*P. anthracophilus*, Cooke. 174—*P. sulphureus*, Fr. 175—*P. rosettus*, Lloyd. 176—*P. rufescens*, Pers. 177—*P. Albertini*, Mueller. 178—*P. eucalyptorum*, Fr. 179—*P. gilvus*, Schw. 180—*P. gilvus*, var. *scruposus*, Fr. 181—*P. (Trametes) pertusus*, Fr. 182—*P. Patouillardii*, Rick. 183—*P. fruticum*, Berk. 184—*P. sessilis*, Murr.

Fomes: 185—*F. robustus*, Karsten. 186—*F. conchatus*, Pers. 187—*F. densus*, Oleson. 188—*F. roburneus*, Fr. 189—*F. rimosus*, Berk. 190—*F. badius*, Berk. 191—*F. pseudosenex*, Murr. (?) 192—*F. yucatensis*, Murr.

Poria: 193—*P. callosa*, Fr. 194—*P. vaporaria*, Fr.

Trametes: 195—*T. lactinea*, Berk. 196—*T. protea*, Berk. 197—*T. semitosta*, Berk.

HYDNACEAE.

HYDNUM: 198—*H. rufescens*, Pers. 199—*H. coralloides*, Scop. 200—*H. ochraceum*, Pers. 201—*H. Muelleri*, Berk. 202—*H. zonatum*, Batsch. 203—*H. alutaceum*, Fr.
TREMELLODON: 204—*T. gelatinosum*, Scop.
RADULUM: 205—*R. Neilgherrense*, Berk.
IRPEX: 206—*I. consors*, Berk. 207—*I. cingulatum*, Lloyd. 208—*I. saepiaria*, Lloyd.

THELEPHORACEAE.

THELEPHORA: 209—*T. terrestris*, Ehrenb. 210—*T. myriomera*, Fr.
STEREUM: 211—*S. caperatum*, Berk. and M. 212—*S. elegans*, Fr. 213—*S. semilugens*, Kalchb. 214—*S. hirsutum*, Willd. 215—*S. zonarium*, Lloyd. 216—*S. vellereum*, Berk. 217—*S. lobatum*, Fr. 218—*S. illudens*, Berk. 219—*S. membranaceum*, Fr. 220—*S. (Lloydella) cinerascens*, Schw. 221—*S. (Hymenochaete) adustum*, Lev.
CORTICIUM: 222—*C. coeruleum*, Pers.

GASTEROMYCETES.

CHLAMYDOPUS: 223—*C. Meyenianus*, Berk.
BATTAREA: 224—*B. phalloides*, var. *Stevenii*.
GEASTER: 225—*G. Clelandii*, Lloyd. 226—*G. floriformis*, Vitt. 227—*G. simulans*, Lloyd. 228—*G. Berkeleyi*. 229—*G. minimus*, Schw. 230—*G. saccatus*, Fr.
MYCENASTRUM: 231—*M. corium* (Guers.).
LYCOPERDON: 232—*L. gemmatum*, Batsch.
CALVATIA: 233—*C. lilacina* (Berk.).

ASCOMYCETALES.

ENDOGONE: 234—*E. tuberculosa*, Lloyd.
MORCHELLA: 235—*M. esculenta*, L. 236—*M. conica*, Pers.
LEOTIA: 237—*L. marcida*, Pers.
GEOGLOSSUM: 238—*G. Muelleri*, Cooke. 239—*G. glabrum*, Pers.
PHILLIPSIA: 240—*P. polyporoides*, Berk.
URNULA: 241—*U. campylospora*, Berk.
HYPOMYCES: 242—*H. aurantius*, Tul.
XYLARIA: 243—*X. anisopleura*, Mont. 244—*X. phosphorea*, Berk. (?) 245—*X. myosurus*, Mont. (?) 246—*X. faveolis*. 247—*X. hypoxylon*, Grev.
SARCOXYLON: 248—*S. Le Rati (Hennings)*.
PORONIA: 249—*P. punctata*, L. 250—*P. oedipus*, Mont.
NUMMULARIA: 251—*N. Baileyi*, B. and Br.
DALDINIA: 252— *D. concentrica*, Bolt.

WHITE-SPORED AGARICACEAE.

AMANITA.

90. *Amanita grossa*, Berk. *Agaricus (Amanitopsis) grossus*, Berk.: Fl. Tasm., ii., 242; Sacc.: Syll., 23; Cooke: Handb. Austr. Fungi, No. 10 (Tasm.). *Agaricus (Amanita) ananaeceps*, Berk. (?): Hook, Lond. Journ., viii., 572; Sacc.: Syll., 36; and Cooke: Handb. Austr. Fungi, No. 8 (Tasm.).—We sent specimens of our plants to Miss E. M. Wakefield at Kew, asking if they were *A. solitaria*. She

has replied that they do not seem to be so, as *A. solitaria* has floccose and easily removed warts; their smell seems to exclude *A. strobiliformis*. She suggested that they might be *A. grossa* or *A. ananaeceps*. On referring to the brief descriptions of these two, it seems probable that they may refer to different stages of the one species. As the specimens of one of our collections agree very well with the description of *A. grossa*, we place our plants under this name, though if only one species is concerned *A. ananaeceps* has priority. A composite description of our specimens is as follows:—Pileus 4½ to 7 inches in diameter, globose then convex, white sometimes with a silvery tinge, shining, covered with scattered warts which have a broad base of puckered membrane and a projecting ragged apex as if a piece of tissue paper had been twisted round with the fingers, with large soft ragged fragments of the veil attached to the edge. Gills just reaching the stem, moderately close, of a dirty creamy-white colour, drying to a darker tint. Stem up to 6 inches high, up to 1¾ inch thick at the bulbous base and 1 inch in the upper part, solid (in one a little hollowed out above, probably from insects), mealy-white, above sometimes with narrow ragged irregular rings from the veil, sometimes with no ring, the upper part of the bulb smooth, the lower with concentric rings of small warts. Spores 8·5 to $10{\cdot}4 \times 6{\cdot}8$ to 7·2 μ, not thick walled. A strong sour smell as of rancid butter. In one specimen the gills showed frequent anastomoses by cross-veins forming elongated cells. Narrabeen, March, 1916; Kendall, December, 1917.

Amanitopsis.

91. *Amanitopsis punctata*, n. sp.—Pileus up to 3½ inches in diameter, at first globose, then convex, sometimes gibbous, then plane or slightly depressed, smooth, slightly sticky when moist, edge markedly striate or even sulcate, with occasional patches of the volva especially near the edge when young, very dark grey, greyish-brown or smoky-grey, darker in the centre. Gills just free, showing lines on the adjacent part of the stem, close, greyish-white to very pale smoky-grey, edges darker and finely serrate. Stem 4 to 5½ inches high, stout, ½ inch thick below, slightly attenuated upwards, finely striate, hollow below with pith, finely spotted with greyish fibrous scales forming striae below, or with fine dark cobweb-like fibrils. Volva sheathing, ample, greyish-lead colour. Spores spherical, thick-walled, 10·4 to 14, occasionally 17 or 18 μ. After heavy rain, Bradley Head, Sydney, March to May; Mosman, April (D. I. C., Watercolour 62; Herb., J. B. C., Formalin Sp. 165)

Colour tints noted:—Pileus smoke-grey (pl. 313, Ton 4). Stem flecked with smoke-grey (pl. 313, Ton 4). Gills very pale smoke-grey or greyish-white.

Pileus ad 8·7 cm. latus, primo globosus, deinde convexus, interdum gibbosus, deinde planus aut depressus, glaber, margine striata, fumoso-cinereus. Lamellae subdisjunctae, confertae, cinereo-albidae, marginibus percinereo-albidis et subserratis. Stipes 10 ad 13 cm. altus, crassus, sursum subattenuatus, substriatus, deorsum cavus, fumoso-cinereus et punctatus. Volva vaginata, ampla, fumoso-cinerea. Sporae sphericae, 10·4-18 μ.

This species is clearly closely related to, but quite distinct from, *A. vaginata*, Roze, which we have also collected. We have come upon our species on several occasions, and it has always presented the same characters. The colour of the gills, punctate grey stem, and size and shape of the spores are distinctive features. We have designated it "punctata" from the appearance of the stem. (Pl. xxviii.)

Armillaria.

92. *Armillaria mellea*, Vahl; Cooke: Illustrs., pl. 32; Cooke: Handb. Austr. Fungi, No. 47; Clel. and Cheel: Agr. Gaz., N.S. Wales, xxvii., 1916, p. 104, pl. 4.—Ararat, Vict., May, 1917 (E. J. Semmens, No. 24); National Park, S. Austr., April and June, 1917; Kendall, N.S. Wales, May, 1917; near banana (*Musa*, sp.), Botanic Gardens, Sydney, July, 1916.

In May, 1917, an interesting form was found at Mosman, Sydney, growing in a dense caespitose mass at the base of a stump. The cap was almost black with dense short fibres. There were definite remains of a pale-brownish ring ⅞ inch below the cap, whilst just below the cap itself was a flimsy veil rupturing to form a very definite second ring.

93. *Armillaria mucida*, Schrad., var. *exannulata*, var. nov.—Cap up to 4 inches in diameter, slightly convex, then plane, glutinous, edge a little striate, whitish to pale stone-brown, cuticle peels. Gills very slightly sinuate, slightly ventricose, moderately distant to distant, white. Stem 3½ inches high, slender to quite stout, bulbous below, attenuated upwards, slightly fibrously streaked, fibrous, tough, white to whitish, solid. Spores spherical, granular, thick-walled with a "nucleus," white, 15·5 to 24 μ, basidia and hyphae large in proportion. On rotting fallen trunk, Mummulgum Brush, near Casino, December, 1916.

Even in young specimens we can find no sign of a ring. The plants are obviously like a large ringless *Armillaria*

mucida, and on comparison with dried English specimens received from Miss Wakefield, the spores of the latter are found to be similar to those of our plants but smaller (15·5 to 17·3 μ). Obviously the Australian plants are very close relatives to *A. mucida*, probably being the Australian representatives, and, in spite of the complete absence of a ring, we place them under *A. mucida* as a variety rather than transfer them as a new species to another genus, and so lose their obvious affinity.

Pileus ad 10 cm. latus, subconvexus, deinde planus, glutinosus, substriatus, albidus ad subfusco-albidus, cuticulo decorticante. Lamellae subsinuatae, subventricosae, subdistantes ad distantes, albae. Stipes ad 8 cm. altus, tenuis ad robustus, ad basem bulbosus, albus ad albidus, solidus. Sporae sphericae, granulatae, 15·5-24 μ.

Tricholoma.

94. *Tricholoma muculenta*, Berk.: Hook. J., 1845, p. 43; Cooke: Handb. Austr. Fungi, No. 50 (W.A.).—The following agaric we are provisionally placing under this specific name, but are not quite sure of its identity with the species:—Pileus 2 inches in diameter, glutinous, white with a tinge of brown at the apex, umbonate (conical), convex then expanded. Gills white (drying to a light brown), moderately distant, just adnexed. Stem white, glutinous, solid, faintly striate (?). Caespitose on bare ground. Taste (dry specimen) mild. Spores white, spherical, 4 to 4·5 μ, warty with an apiculus at one end. Milson Island, Hawkesbury River, May 5, 1913.

This agrees with the original description, save that the spores are a little smaller (5 to 6 μ in Berkeley's species). No mention is made of the spores being warty. No British species of *Tricholoma* agrees with our specimen. There is some resemblance between our fungus and the description of *Russula virginica*, Cooke and Massee. The spores correspond exactly, but our specimen is caespitose, and has not decurrent, crowded gills, and is clearly not a *Russula*.

95. *Tricholoma colossa*, Fr.: Epicr., p. 38; Cooke: Illustrs., p. 87; Massee: Brit. Fung. Flora, iii., p. 182.—A large agaric, usually half buried in the sandy soil, frequently occurring after autumn rain in the coastal district near Sydney, seems referable to this species. The description of *Tricholoma coarctata* given by Cooke and Massee (Cooke: Handb. Austr. Fungi, No. 51) also seems like that of our species, but fig. 5, given by Cooke, is quite different. If this figure is one reconstructed from a rough sketch, and not

a true representation of the original, then it may still happen that our species is that given by Cooke, but until this is settled we leave it under *T. colossa*. The following is the description of our specimens:—Caespitose. Pileus 3 inches in diameter, convex, brownish-tan, somewhat squamulose and cracking, edge turned in when young. Gills crowded, straw-coloured, becoming discoloured rufous, adnate. Stem stout, 2½ inches × 1¼ inch thick, somewhat bulbous, discoloured reddish-brown, white above. Flesh showing pink at the base of the stem and under the cap. Spores pear-shaped, white, 7 × 5·2 μ. Newcastle (Miss Clarke), April, 1915. Other specimens show a cap convex to plane, and finally often upturned, up to 4½ inches in diameter, shining, fawn to reddish-brown, when old often very dark reddish-brown and slimy, broken up more or less into scales; flesh thick; gills adnate or sinuately adnexed, spores 5·5 to 6·8 × 3·8 to 4·2 μ, in some specimens apparently of this species 7 to 8·5 × 5·2 to 7 μ. Narrabeen, April; Sydney, April and May; Hawkesbury River, April.

CLITOCYBE.

SECT. I.—DISCIFORMES.

96. *Clitocybe media*, Peck.—Peck's description (N. York State Mus., Mus. Bull. 157, p. 61) is as follows:—"Pileus fleshy, convex, becoming plane or slightly depressed in the centre, often wavy or irregular on the margin, not polished, greyish-brown or blackish-brown, flesh white, taste mild; lamellae broad, subdistant, adnate or decurrent, whitish, the interspaces often venose; stem equal or nearly so, solid, elastic, coloured like or a little paler than the pileus; spores ellipsoid, 8 × 5 μ. Pileus 5 to 19 cm. broad; stem 2·5 to 5 cm. long, 8 to 16 mm. thick. Gregarious or scattered. Mossy ground in woods."

We have not had access to his plates of the species. The following South Australian plants approximate to the description of *C. media*, though differing in some details, *e.g.*, the pallid-whitish stem. They differ from *C. nebularis*, Batsch, in their larger spores, and from *C. clavipes*, Pers., in the non-clavate stem and non-decurrent gills. There seems justification for the present in placing them under *C. media*.

Pileus up to 6 inches across, convex, then plane or a little upturned, somewhat irregular and wavy, subgibbous, matt, centre smoky-brown, the rest moist-looking yellowish-stony-brown. Flesh whitish, moist-looking in places. Gills adnate, close, whitish, then rather pallid or creamy. Stem up to 1¾ inch high, slender to stout (up to ¾ inch thick), rather attenuated in the middle, slightly fibrillose or fibrously

streaked, solid, pallid whitish. Hardly any smell. Spores 8·5 to 10·4 × 5 μ. In a garden amongst grass, Beaumont, Adelaide, and on the Mount Lofty Range above Beaumont amongst grass under a tree, June, 1917. (Miss Rennie, Watercolour No. 3.)

97. *Clitocybe pinophila*, Peck.—Peck's description (N. York State Mus., Mus. Bull. 157, p. 63) is as follows:—"Pileus fleshy, thin, convex becoming umbilicate or centrally depressed, glabrous, pale-tan colour when moist, paler when dry, odour and taste farinaceous; lamellae moderately close, subarcuate, adnate or slightly decurrent, whitish; stem equal, glabrous or slightly pruinose, coloured like the pileus; spores broadly ellipsoid or subglobose, 5 to 6 × 4 to 5 μ. Pileus about 2·5 cm. broad; stem 2·5 to 5 cm. long, 2 to 4 mm. thick. Gregarious. Under or near pine trees. Sometimes the pileus becomes striate on the margin in drying."

Though the spores of the following Australian plants growing under pines are slightly narrower and the gills seem to have a greyish tint, it seems probable from Peck's description that they may be his species. Possibly they are better referred to the Sect. Orbiformes. Pileus up to 2 inches across, convex or plane, sometimes slightly depressed, thin, surface matt, when moist greyish-brown and translucent, when dry pallid brownish and opaque, edge turned in when young. Gills adnate to slightly decurrent, close, pallid whitish then pallid greyish. Stem up to 2 inches high, moderately slender, slightly attenuated downwards, slightly striate, often flattened, pallid brownish or pallid greyish-brown, hollow. Very slight fragrant mealy odour. Spores 5·2 to 7 × 2·5 to 3 μ. Amongst grass, apparently usually (always [?]) under *Pinus*. Beaumont, near Adelaide, and National Park, S. Austr., June, 1917; amongst pine needles under *Pinus*, Craigie, Ararat (E. J. Semmens, No. 146).

98. *Clitocybe dealbata*, var. *minor*, Cooke: Handb., p. 50; Cooke: Illustrs., pl. 173.—Small plants, growing on the ground or attached to grass or fern roots at Milson Island, Hawkesbury River, in April and November, seem to be var. *minor* of this species. They were pure white, sometimes with a yellowish tinge when old, convex and somewhat irregular, with moderately distant gills. Occasional specimens were truncate above, descending conically with deeply decurrent gills. Spores elliptical, 5·5 to 6·6 × 3·4 μ.

SECT. IV.—CYATHIFORMES.

99. *Clitocybe cyathiformis*, var. *cinerascens*, Fr.—We have collected specimens of this variety at Mosman, Sydney,

in March, May, and June, and at Lisarow in May. Reticulations have not been noted on the stems. The description of our plants is as follows:—Pileus up to 1½ inch in diameter, very thin, translucent, pale greyish-brown, striate, sometimes somewhat rugose, umbilicate to infundibuliform. Gills moderately crowded, deeply decurrent, branching and anastomosing. Stem up to 2¼ inches high, tubular, and the hollow centre sometimes apparently communicating with the funnel-shaped cap, base slightly bulbous, of the same colour as the cap but browner below. Spores pear-shaped with a large vesicle, 7 to 8·5 × 4·2 to 5 μ. Under trees, sometimes on rotten wood. (D. I. C., Watercolour 38.)

SECT. V.—ORBIFORMES.

100. *Clitocybe paraditopa*, n. sp.—We have met with the following species of *Clitocybe* on several occasions in New South Wales and South Australia. It has usually been found on or in the neighbourhood of cow-dung, and, if this habit is a necessity, is evidently an introduced species. From the descriptions and from Cooke's illustrations of *C. ditopa*, Fr., it seems close to this species but, from comparison with dried plants kindly forwarded to us from England by Miss E. M. Wakefield, is clearly not identical with it. It also seems, from the description, to be close to *C. subditopoda*, Peck. Its outstanding feature is a strong scent of wattle blossom, noticeable even at a distance as when walking near. Pileus 1½ to 2½ inches in diameter, slightly convex and irregular, the centre sometimes slightly depressed or almost infundibuliform, sometimes obscurely gibbous, smooth, when moist shining moist-looking pallid stony-grey to brownish, drying from the centre, which become pallid fawn, and finally pallid white and shining, sometimes when dry dingy greyish-white, edge incurved when young. Gills moderately crowded to moderately distant, adnate, sometimes somewhat decurrent, rather thick, narrow, French grey, dark grey or violet-grey, becoming dark greyish-brown. Stem 1½ to 2 inches high, moderately stout or slender, often compressed and deformed, slightly fibrously streaked, rigid, usually markedly hollow, occasionally when young nearly stuffed, whitish. Often densely caespitose and deformed, on bare rich soil or under *Casuarina* twigs, etc., in or near cow-dung or in pastures. Strong scent of wattle blossom (*Acacia pycnantha* or *suaveolens*). Spores with one end a little pointed, 5·2 to 6·8 × 2·6 to 3·6 μ. Milson Island, Hawkesbury River, April to July; The Oaks, N.S. Wales, June, 1914; Adelaide, July, 1914 (spores 7 × 3·8 μ). (Miss Clarke, Watercolour 79; D. I. C., Watercolours 50 and 51.)

Pileus 3·7 ad 6·2 cm. latus, subconvexus et irregularis, modo depressus, modo subgibbosus, glaber, hygrophanus, pallido-cinereo-fuscus, siccatus pallidus et nitidus. Lamellae adnatae, interdum subdecurrentes, angustae, pallido-cinereae aut violaceo-cinereae, deinde cinereo-fuscae. Stipes 3·7 ad 5 cm. latus, saepe distortus, cavus, albidus. Habitus saepe caespitosus. Odor fragrans. Spores 5·2-6·8 × 2·6-3·6 μ.

Coloured figures of this new species were prepared by the Government Printer of New South Wales several years ago for publication in the Agricultural Gazette of N.S. Wales. Owing to the war such publication has had to be postponed, but it is hoped that the plate may appear in that journal during 1920.

CANTHARELLUS.

101. *Cantharellus lilacinus*, n. sp.—Pileus up to 1 inch in diameter, convex and edge turned in when young, then slightly convex or even depressed, often deformed, surface matt or almost floccose, of a brilliant artificial-looking pinky-lilac. Gills markedly decurrent from the first, very distant, often branching, many short, edge rather thick, white or with a lilac tint. Stem up to 1½ inch long, 3/16ths inch thick, moderately stout, equal, lilac above, a pale dull-yellow below. Flesh thick, lilac above, that of the stem white. Spores pear-shaped, 7 to 8·5 × 4·5 to 5·5 μ. Under *Kunzea* bushes, Gladesville, Sydney, June, 1916. (Miss Clarke, Watercolour 115.)

Pileus ad 2·5 cm. latus, convexus, deinde subconvexus aut depressus, saepe distortus, subfloccosus, rosaceo-lilacinus. Lamellae decurrentes, distantes, saepe furcatae, marginibus crassis, albae vel sublilacino-albae. Stipes ad 3·7 cm. altus, ·5 cm. crassus, equalis, sursum lilacinus, deorsum pallido-croceus. Caro crassa, sursum lilacina, in stipite alba. Sporae pyriformes, 7-8·5 × 4·5-5·5 μ. (Pl. xxix., fig. 1.)

102. *Cantharellus imperatae*, n. sp.—The following species, which we refer to the genus *Cantharellus*, though it approaches *Clitocybe*, has occurred during successive years on a patch of the grass *Imperata arundinacea* growing at Neutral Bay, Sydney. It especially occurs after heavy rains when the grass has been burnt and is attached in small gregarious masses to the bases of the stems near the ground. Pileus up to ⅝ inch or more in diameter, convex, subgibbous, then plane or a little depressed, somewhat irregular, edge turned in especially when young, surface matt, pale fawny-white in centre with the periphery paler or nearly pure white, later

with a brownish tint. Gills adnate, then decurrent, edges rather thick and entire, moderately distant, sometimes branching and connected by irregular cross-veins, white with an orange tint when dry. Stem up to $1\frac{3}{4}$ inches high, markedly attenuated downwards, slightly hollow, white and somewhat mealy above, mouldy greenish-grey and mealy below. Spores obliquely pear-shaped or flask-shaped, one end acute, with a central globule, 9 to $13{\cdot}8 \times 5{\cdot}2$ to 7 μ. Neutral Bay, Sydney, February, March, and almost at any time after heavy rain.

Pileus ad 1·5 cm. aut plus latus, convexus, subgibbosus, deinde planus vel subdepressus, paulo irregularis, margine inverto, subcervino-albidus vel albus, deinde subfusco-albidus. Lamellae adnatae, deinde decurrentes, marginibus crassis, subdistantes, interdum furcatae et venis connectantibus, albae. Stipes ad 2 cm. altus, deorsum attenuatus, subcavum, sursum albus et subfarinaceus, deorsum sub-viride-glaucus et farinaceus. Sporae obliquae, pyriformes, 9-$13{\cdot}8 \times 5{\cdot}2$-7 μ.

As indicated under *Clitocybe paraditopa* (No. 100), it is hoped that a coloured figure of this species, the plate of which has been prepared for some years, may be published in the Agricultural Gazette of N.S. Wales in 1920.

103. *Cantharellus nigripedes*, n. sp.—Pileus $\frac{3}{4}$ inch in diameter, slightly convex to nearly plane, centre sometimes depressed, very thin, distantly ribbed, rather fragile, white with a pale-brownish tint, darker in the centre, edge turned in when young. Gills adnate, pure white, moderately distant, many short, sometimes with irregular branching veins, edges a little thick. Stem up to $1\frac{1}{2}$ inch high, very slender, slightly attenuated downwards, tough, black except near the apex which is white, nearly wholly white when very young, slightly greyish-mealy. Spores (?) $4 \times 2{\cdot}5$ μ. Attached by a very small disk to fallen trees, etc., near brush. Murwillumbah, N.S. Wales, April, 1916. (Herb., J. B. C., Form. Sp. 204.)

Pileus ad 2 cm. latus, subconvexus ad subplanus, tenuis, costatus, subfragilis, albidus sed pallido-fusco tinctus. Lamellae adnatae, albae, subdistantes, interdum venis irregularibus et ramosis, marginibus crassis. Stipes ad 3·75 cm. altus, pertenuis, deorsum attenuatus, lentus, niger sed apice albo. Sporae (?) $4 \times 2{\cdot}5$ μ.

104. *Cantharellus corrugatus*, n. sp.—Pileus 1 inch in diameter, irregularly convex, then expanded with the edge a little flattened, the edge turned in when young, when moist semitranslucent greyish-white and striate, drying from the centre to become pure white and scarcely striate. Gills

distant, many short, sometimes forked and connected by numerous transverse wrinkles, white. Stem $2\frac{1}{4}$ inches high, a little wavy, becoming attenuated at the base, hollow, rather cartilaginous, white with a slight brown tint below. Spores 7 to $8 \cdot 5 \times 3 \cdot 8$ μ. Subcaespitose amongst dead wood at the base of a log. Kendall, May, 1917. (Miss Clarke, Watercolour 159; Herb., J. B. C., Form. Sp. 282.)

Pileus 2·5 cm. latus, irregulariter convexus, deinde expansus, primum margine incurvato, substriatus, semitranslucidus et subcinereo-albidus, siccatus albus. Lamellae distantes, interdum furcatae, venis frequentibus connectantibus, albae. Stipes 6·2 cm. altus, deorsum attenuatus, cavus, albus, deorsum subfusco-albidus. Sporae $7\text{-}8 \cdot 5 \times 3 \cdot 8$ μ. Plantae subcaespitosae.

We have given the specific name "*corrugatus*" to the species on account of the wrinkled appearance presented by the intercommunicating veins. (Pl. xxix., fig. 2.)

105. *Cantharellus foliolum*, Kalch.: Grev., ix., 134; Sacc: Syll., v., 1956; Cooke: Handb. Austr. Fungi., No. 414 (Q.).—We have specimens, apparently of this species, taken on fallen sticks and twigs at Mosman, Sydney, in April and November. The plants are small and pure white, showing a greyish tinge in drying. The gills are very irregular. Spores pear-shaped, 12 to $13 \cdot 8 \times 7 \cdot 2$ μ. (Herb., J. B. C., Form Sp. 88.)

Lactarius.

Subgenus I.—Piperites.

106. *Lactarius (Piperites) stenophyllus*, Berk.: Fl. Tasm., ii., p. 248, t. 181, fig. 8; Cooke: Handb. Austr. Fungi, No. 388.—A comparison of the following specimens with Berkeley's rather crude figure of this species leaves no doubt in our minds that they are one and the same. Before referring to Berkeley's description, we had noted the resemblance to *L. insulsus*. Our plants we describe as follows:—Pileus up to 3 inches across, convex, often irregular, usually markedly infundibuliform, pale yellowish-brown, often somewhat zoned, slightly viscid when moist, edge markedly incurved when young. Gills very crowded, adnate to slightly decurrent, creamy-yellow becoming dirty yellowish-brown, apparently not pruinose from the spores. Stem up to $1\frac{1}{2}$ inches high, moderately slender to stout, slightly expanded above, white, rather mealy. Exuding copious white milk from the gills on the slightest injury and juice from the stem. Instantly peppery. Spores warty, spherical, 5 μ. Under trees, Ryde, Sydney, May, 1916. (Miss Clarke, Watercolour 105.)

SUBGENUS III.—RUSSULARIA.

107. *Lactarius (Russularia) subtomentosus*, B. and Rav.: Ann. Nat. Hist., Oct., 1869; Cooke: Handb. Austr. Fungi, No. 391 (Vict., N.S. Wales).—Specimens which we refer to this species have been obtained at the Hawkesbury River and at Lisarow, both in May. Their description is as follows:—Pileus 4½ inches in diameter, convex to irregularly infundibuliform (funnel-shaped), brownish-umber, villous looking, rigid. Gills pale cream, distant, many short, deep, decurrent. Milk abundant, white, mild. Stem up to 2 inches long, usually rather eccentric, double in one specimen, matt, pale brownish to brown, becoming hollow. Spores spherical, warted, 7 to 9 μ. Under trees.

108. *Lactarius (Russularia) serifluus*, Fr.: Epicr., p. 345; Cooke: Illustrs., 1012; Massee: Brit. Fung. Flora, iii., p. 32.—Our specimens may be described as follows:—Pileus when small convex and slightly umbonate, later expanded with centre depressed and sometimes infundibuliform, rich reddish-tan to dark velvety reddish-brown. Gills adnate, some forked near the stem or near the edge, some very short ones interposed near the edge between long ones, very pale brown to salmon or tawny-white. Stem central or eccentric from distortion, reddish-brown like the cap, whitish at the base, finally hollow. Slightly caespitose under trees. Spores very rough, spherical to oval, 6·5 to 7, $8 \times 6{\cdot}5$ μ. Neutral Bay, Sydney, May, June, November; Lane Cove River, June; Bulli Pass, November.

RUSSULA.

109. *Russula adusta*, Fr.: Epicr., p. 350; Cooke: Illustrs., pl. 1051; Massee: Brit. Fung. Flora, iii., p. 52.—We have collected this species on three occasions. The following is the description of specimens from the Blue Mountains obtained in May, 1914:—Pileus convex, deeply depressed, pallid becoming tinged darker brown, not viscid, rigid, edge turned in. Flesh becoming dark grey. Gills crowded, fading off towards the stem, pure white becoming dark greyish-black. Stem 1 inch high, ⅝ inch thick, white becoming sooty, finely pruinose. Taste mild. Spores warty, slightly oval, $8{\cdot}5 \times 8$ μ (in the other collections, the spores are spherical to irregular, 7 to 9 μ). In specimens collected at Lane Cove River, Sydney, in May, fine woolly scales were noted on the cap.

110. *Russula Flocktonae*, n. sp.—Pileus up to 4 inches in diameter, irregularly convex, then depressed, pale pinkish-fawn, pale yellowish-brown, dull reddish-orange or brilliant velvety buff-orange. Gills adnate, moderately to widely separate, occasionally bifurcating, interspersed with short

ones, pure white, becoming darker and pruinose from the spores. Stem 1 to 1½ inch high, stout, sometimes attenuated downwards, solid, reddish-brown to pinkish-buff. Substance white. Taste mild, occasionally slightly peppery. Spores elliptical, warty, 8·5 to 10·8 × 7 to 8·5 μ, occasionally more spherical. Elongated cystidia, 26 μ long, seen in two collections. On the ground under trees, Ryde, Sydney, May; The Spit and Bradley Head, Sydney, June; Lane Cove River, Sydney, May; Hawkesbury River, April, June; Terrigal, June. (Miss Margaret L. Flockton, Watercolour A.)

We have been unable to find any figure or description agreeing with this species, and so describe it as new. We have named it in honour of Miss Flockton, who has admirably delineated it, and who for many years has taken a special interest in fungi.

Pileus ad 10 cm. latus, irregulariter convexus, deinde depressus, pallido-rosaceo-cervinus ad luteo-aurantiacus. Lamellae adnatae, subdistantes ad distantes, interdum bifurcatae, albae deinde pallidae et pruinosae. Stipes 2·5 ad 4 cm. altus, robustus, interdum deorsum attenuatus, solidus, rubro-subfuscus ad rosaceo-cervinus. Caro alba. Insipidus, interdum subpiperatus. Sporae ellipticae, verrucosae, 8·5-10·8 × 7-8·5 μ. Interdum cystidiis.

As indicated under *Clitocybe paraditopa* (No. 100), it is hoped that coloured plates of this species, with others, may be published in the Agricultural Gazette of N.S. Wales in 1920.

111. *Russula Mariae*, Peck.—Peck's description (N. York State Mus., Bull. 75, 1903 (1904), p. 29, pl. 85, figs. 1-8) of this species is as follows:—"Pileus at first nearly hemispheric, soon broadly convex, nearly plane or centrally depressed, pruinose and minutely pulverulent, dark crimson or purplish, sometimes darker in the centre than on the margin, rarely striate on the margin when old, flesh white, pinkish under the cuticle, taste mild; lamellae moderately close, adnate, white when young, pale yellow when old; stem equal, solid or slightly spongy in the centre, coloured like or a little paler than the pileus, usually white at the top and bottom, rarely entirely white; spores pale yellow, globose, ·003 of an inch broad." From this description and from the coloured figures given by Peck, we think there is little doubt that the common mild-tasted purple-capped *Russula* with a rosy-pink stem found in the Sydney district is *R. Mariae*. Perhaps the specimens of *R. purpurea*, Gill. (*R. Queletii*, var. *purpurea*, *vide* Massee), recorded by Cooke (No. 395) for Victoria are also this species, but *R. purpurea* is an acrid species.

We describe our specimens as follows:—Pileus up to $2\frac{1}{4}$ inches in diameter, convex, centre depressed, edge sometimes turned up, of various tints of dark purple, purplish-red, rosy-purple, or pallid yellow, the general tone being purplish, edge slightly striate, cuticle occasionally apparently slightly sticky when moist. Flesh white, perhaps faintly purple under the thick cuticle. Gills moderately close, white, becoming pale yellowish, fading away at the stem to adnate. Stem moderately stout, a little swollen below or sometimes attenuated downwards, tinged with rosy-pink, rarely whitish only, hollow, pithy, base rooting. Spores warty, spherical to slightly oval, 7·2 to 9 μ. Taste mild. Sydney, May; Milson Island, Hawkesbury River, March, April, May, November; Mount Lofty, S. Austr., July (gills yellow). Portions fed to a pig and to a rabbit produced no ill-effects. (Miss Clarke, Watercolour 65.)

The following are in the National Collection at the Botanic Gardens, Sydney:—Helensburgh (W. Craigie); Leura (A. A. Hamilton), April, 1908; Mosman (E. Cheel), May, 1912; Gladesville (Miss M. Flockton), April, 1910; Hawkesbury River (J. B. Cleland), April, 1910; Brownsville (E. Cheel), April, 1910.

112. *Russula xerampelina*, Fr.: Epicr., p. 356; Cooke: Illustrs., pls. 1053 and 1074; Massee: Brit. Fung. Flora, iii., p. 60.—We refer the following to this species. It agrees well with the illustrations given by Cooke:—Pileus up to $3\frac{1}{2}$ inches across, irregular, rather depressed in the centre, splitting and cracking, pallid whitish blotched with bright-brownish vermilion. Gills adnate, moderately close, sometimes forking, occasionally in deformed specimens forming irregular pores near the stem, pale buffy-white. Stem $2\frac{1}{2}$ inches high, $1\frac{1}{2}$ inch thick above, stout, attenuated downwards, root rather conical, fibrously striate, white with tinges of pinkish. Flesh solid, white. Slight smell. Rather rigid. Taste mild. Spores pale-tinted microscopically, warty, 8·5 to 10·5 μ. Partly buried in the ground. Mount Lofty, S. Austr., April, 1917.

113. *Russula azurea*, Bres.: Fungi Trident., t. 24; Cooke: Illustrs., pl. 1088; Massee: Brit. Fung. Flora, iii., p. 57.—The following resembles Cooke's illustrations of *R. cyanoxantha*, Schaeff., but cystidia have not been found. For the present at least we refer it to *R. azurea*, which resembles *R. cyanoxantha*, and has no cystidia:—Pileus 1 inch across, convex and dimpled atop, finally 3 inches across and depressed, definitely sticky when moist, not striate, when small the colour usually blotchy purplish with stone tints between, sometimes with distinct greenish tinges; tending to crack into small

purplish-brown scales or to become blotchy bluish-green and brownish-yellow in the centre, when old pale brownish with shades of dull bluish-green, cuticle separable. Gills adnate, close, all equal, sometimes forked, sometimes slightly anastomosing at the stem, diminishing towards the stem and rounded externally, white or creamy. Stem up to 1¾ inch high and up to ⅝ inch thick, slightly attenuated downwards, mealy, very slightly striate, solid, white. Taste mild. Shed spores white, spherical, warty, 7 to 8·5 μ. Neutral Bay, Sydney, March and May, 1917; Narrabeen, March, 1916; North Bridge, Sydney, July, 1916. (Miss Clarke, Watercolour 147.) A similar plant obtained at Sydney in March, 1916, had a very slightly peppery taste. Probably the same species, with the cap pallid brownish-white with dull greyish-green blotches, was collected at Mount Lofty, S. Austr., in April, 1917 (spores 6 to 7 μ).

114. *Russula granulosa*, Cooke: Handb., p. 332; Cooke: Illustrs., pl. 1038; Massee: Brit. Fung. Flora, iii., p. 69.—The punctate brown spots on the stem, the cystidia, and the acrid taste seem to indicate with reasonable certainty that the following is this species:—Pileus when young somewhat dome-shaped and irregular with the edge sharply turned in, then irregularly convex, finally expanding up to 4 inches in diameter, smooth but sometimes with a few wrinkles, or slightly fibrously streaked, edge plicate, somewhat viscid when moist, cuticle not separable, yellowish-brown. Flesh thick, becoming attenuated towards the edge, white. Gills adnate to adnexed, moderately close, edges darker and very slightly serrate, creamy, when bruised becoming brownish. Stem 1½ to 2½ inches high, attenuated downwards, mealy-white with a tinge of ochre or with fine scattered punctate brown spots. Taste intensely peppery and somewhat bitter. Spores warty, 7 to 9 μ; a few projecting acuminate cystidia, 42 × 12 μ. Narrabeen, March, 1916, and February, 1917; Kew, January, 1917; Neutral Bay, Sydney, March, 1917. (Miss Clarke, Watercolour 90.)

115. *Russula pectinatoides*, Peck.—Peck's description (N. York State Mus., Bull. 116, p. 90) of this species is as follows:—"Pileus thin, broadly convex, becoming nearly plane or centrally depressed, viscid when moist, widely tuberculose striate on the margin, dingy straw colour, brownish, yellowish-brown or cinerous brown, sometimes darker in the centre, flesh white, greyish-white under the separable pellicle, taste mild or slightly and tardily acrid; lamellae thin, equal or with an occasional short one, some forked at the base, adnate, white becoming pallid; stem equal or nearly so, even, glabrous, spongy within, white; spores whitish, subglobose; ·00025-·0003

of an inch long, nearly or quite as broad. Pileus 1-3 inches broad; stem 1-2 inches long, 3-4 lines thick."

From this description and from Peck's figures, we believe the following to be this species. The stem is, however, usually attenuated downwards and grey under the cap has not been noted:—Pileus up to 3 inches in diameter, slightly convex to infundibuliform, periphery more or less striate, the striae sometimes showing small rounded warts on the ridges, smooth, viscid when moist, edge thin and not turned in, yellowish-brown and paler in the centre, or a brownish centre with a pale-fawn periphery or olive-brown or pale olive. Gills sinuately adnexed or adnato-decurrent, usually fading away near the stem, moderately close, thick, cream becoming spotted with brown or becoming pallid brownish-white. Stem 1½ inch high, about ⅝ inch across above, usually attenuated downwards to ⅜ inch below, sometimes equal, slightly streaky, solid, white or white with a faint greyish tinge. Flesh white, thick in the centre, very thin towards the edge. Taste mild. Spores with a pale-yellow tint, spherical to subspherical, warty, 7 to 10 μ. Under trees, Neutral Bay, Sydney, March, April, May, June; Bulli Pass, April; Hawkesbury River, June; Manly, April.

116. *Russula emetica*, Fr.: Epicr., p. 357; Cooke: Illustrs., pl. 1030; Massee: Brit. Fung. Flora, iii., p. 73; Cooke: Handb. Austr. Fungi, No. 399 (N.S. Wales, Victoria, Tasm.).—An acrid species with a red cap and a tinge of pink on the stem, though in stature more resembling *R. fragilis*, we believe to be *R. emetica*, as the former is not stated to possess a pink tinge to the stem. Other acrid specimens, very similar but with pure white stems, may be the same species as the ones with pink tinges to the stems, but as the stature and general appearance resemble so closely *R. fragilis*, we at present leave them under that species. Our pink-stemmed specimens have a bitter pungent taste and a purplish to purplish-pink cap. Spores warty, 8·5 to $10{\cdot}4 \times 5{\cdot}2$ to 8·5 μ. Sydney, June.

117. *Russula fragilis*, Fr.: Epicr., p. 359; Cooke: Illustrs., pl. 1091; Massee: Brit. Fung. Flora, iii., p. 75; Cooke: Handb. Austr. Fungi, No. 400 (Q'land, Vict., S. Austr.).—Specimens, with the stature and general appearance of this species, have been found at Neutral Bay, Sydney, in June, and at The Spit, Sydney, in July. These may be described as follows:—Pileus 1 inch in diameter, depressed in the centre, deep crimson, edge slightly striate. Flesh reddish under the cuticle. Gills close, adnate, white. Stem 1½ inch thick, slightly fibrously striate, solid. Taste acrid. Spores warty, spherical to oval, 8·5 to 10·5 μ.

118. *Russula erumpens*, n. sp.—Pileus up to 3 inches in diameter, depressed to infundibuliform, pure white or with a dirty-brown tint, surface dull, not polished. Flesh white. Gills adnate, from depression of the pileus with rather a decurrent tooth, crowded, creamy-white, when old rufescent. Stem 1¼ to 2 inches high, ½ to ¾ inch thick, sometimes a little excentric, white or slightly brown-tinted below, stout, equal, solid, dull, not polished. Spores pale rusty, spherical to slightly oval, verrucose, 7 μ, 8·5 × 7 μ. Taste mild. Emerging covered with soil. Neutral Bay, Sydney, January to May (after heavy rain), October and November; Milson Island, Hawkesbury River, April; Eagle on the Hill, Mount Lofty Ranges, S. Austr., April, 1917 (pileus up to 4½ inches across; spores 8·5 to 10·4 × 7 to 7·8 μ, microscopically apparently white). (Miss Clarke, Watercolour 63.)

Pileus ad 7·5 cm. latus, depressus ad infundibuliformis, albus vel subfusco-albidus, non nitidus. Caro alba. Lamellae adnatae, confertae, subluteo-albidae, deinde subochraceae. Stipes 3 to 5 cm. altus, 1·25 ad 1·8 cm. crassus, interdum subexcentricus, crassus, solidus, non nitidus, albus. Sapor non piperatus. Sporae subochraceae, sphericae ad subellipticae, verrucosae, 7 μ, 8·5 × 7 μ.

At one time we thought our species might be *Russula periglypta*, B. and Br., of Ceylon. Through the kindness of Mr. T. Petch, of Peradeniya Gardens, Ceylon, we have received coloured drawings and dried specimens of the Ceylon species which show that the two are clearly distinct.

As indicated under *Clitocybe paraditopa* (No. 100), it is hoped that a coloured figure of this species, the plate of which has been prepared for several years, will be published in the Agricultural Gazette of N.S. Wales in 1920.

Collybia.

Sect. I.—Striaepedes.

119. *Collybia radicata*, Relh. (Syn. *C. eradicata*, Kalch.: *C. olivaceo-alba*, Cke. and Mass.).—The typical form is recorded by Cooke (No. 78) for Victoria, Queensland, Tasmania, and Western Australia. *C. eradicata* (Cooke, No. 79) is recorded for New South Wales and Victoria; as it differs from *C. radicata* only in the stem not being rooting and not being thickened at the base, we adopt Cooke's suggestion that it may be possibly only an accidental variety of the latter, and so sink *C. eradicata* as a synonym. *C. olivaceo-alba* is recorded in Cooke (No. 82), and for Kogarah, New South Wales, by R. T. Baker (Proc. Linn. Soc. N.S. Wales, xxiv. (1899), p. 446) for Victoria and South Australia. From

the description and from Cooke's plate, it is apparent that *C. olivaceo-alba* closely resembles *C. radicata*, the chief point of difference being the black base of the stem of the former. In May, 1915, we found specimens of *C. radicata* in the Sydney district with whitish bases to the stems and growing near these, plants with the abrupt black bases of *C. olivaceo-alba.* Obviously both were the same species, and both showed the large spores—in this case 12 to 13·8 × 10·4 μ—characteristic of *C. radicata* and of *C. olivaceo-alba.* Apparently, therefore, the black-based plants are only a form of *C. radicata* not yet breeding true, and so not entitled to be established as a variety or species. We consider that a variety is a departure from the type due to some innate change and breeding true, whilst a form is a departure from type not necessarily breeding true, sometimes being merely a recognizable or an extreme variation in a variable species, sometimes being the result merely of environment, as in depauperate examples. On these grounds we sink *C. olivaceo-alba* to the level of a synonym of *C. radicata.*

SECT. II.—VESTIPEDES.

120. *Collybia velutipes*, Fr. Cooke: *loc. cit.*, No. 85 (Vict.).—On a fallen log near Wauchope, N.S. Wales, in February, 1917, a number of dried specimens of a *Collybia* were found almost identical with dried specimens of *C. velutipes* kindly forwarded by Miss E. M. Wakefield from England. They revived perfectly on being placed in water, but were not then viscid: the edge of the cap was also tuberculo-striate, which is not mentioned in the description of *C. velutipes.* Spores 7 to, usually, 8·5 × 5·2 μ; of the English specimens 8 to 8·5 × 3·4 μ.

121. *Collybia confluens*, Pers. Massee: Brit. Fung. Flora, iii., p. 130.—Plants collected by E. J. Semmens (No. 40) amongst pine needles at Craigie, near Ararat, Victoria, in June, 1917, seem indistinguishable from dried English specimens of this species received from Miss E. M. Wakefield. Spores 5 to 7 × 3 μ.

122. *Collybia ingrata*, Schum. Massee: Brit. Fung. Flora, iii., p. 131.—Pileus up to 2¼ inches across, convex, gibbous, the thin edge rather upturned, edge frayed, somewhat striate, pale to dark brown, sometimes chestnut. Gills adnate, moderately to very crowded, rather thick, edges finely serrate, livid or pallid brown. Stem up to 3 inches long, wavy, slender, clad with a dense velvetty-greyish bloom, stem brown when this is rubbed off, when moist brownish with a white bloom, cartilaginous, rather stringy. Spores with one

end more pointed, 7 to 9 × 3·4 to 4 μ. Under bushes, Mosman, Sydney, April, May.

123. *Collybia stipitaria*, Fr. Massee: Brit. Fung. Flora, iii., p. 129.—We have collected this species on one occasion on Milson Island, Hawkesbury River, in March. As mentioned by C. G. Lloyd (Mycolog. Notes, No. 100), it revives on moistening like a *Marasmius*. The description of our specimens is as follows:—Pileus ⅜ inch in diameter, convex, thin, tough, reddish-tan. Gills moderately crowded, pale brown, slightly decurrent. Stem up to ¾ inch high, base slightly swollen, hollow, villous, dark brown. Spores elliptical, 4·4 to 5·2 × 2·5 to 3·4 μ. Attached to the bases of living grass stems. (D. I. C., Watercolour 33.)

Hygrophorus.

Subgenus Hygrocybe.

124. *Hygrophorus miniatus*, Fr. Cooke: Handb. Austr. Fungi, No. 383 (Q'land, Vict.).—Our specimens approach *H. coccineus* in having a tendency to decurrence in the gills and occasionally a trace of yellow at the base of the stem. The spores are also a little smaller than those given for *H. miniatus* or *H. coccineus*. Our specimens may be dsecribed as follows:—Pileus ½ to 1 inch in diameter, convex, sometimes a little dimple in the centre or umbilicate, sometimes irregular, sometimes upturned, sometimes slightly rugose and sometimes slightly squamulose, crimson, sometimes orangey-crimson or reddish-orange or pinky-scarlet. Flesh reddish. Gills distant, yellowish or rosy-pink or pallid, edge rather thick, adnate, becoming decurrent from depression of the pileus or with a decurrent tooth. Stem 1¼ to 2¼ inches high, dilated upwards, solid, sometimes hollow, crimson, with base sometimes slightly yellowish or the buried part whitish and fluffy. Spores elliptical 7 to 8·5 μ, occasionally 10·4 × 3·6 to 6·8 μ. Amongst moss or under trees. Neutral Bay, Sydney, May; Lisarow, May; Mount Wilson, Blue Mountains, June; Leura, June; Blue Mountains, July; National Park, July; Oxford Falls, Narrabeen (Darnell-Smith), October; Tuggerah, October; Hawkesbury River, November.

125. *Hygrophorus conicus*, Fr. Cooke: *loc. cit.*, No. 384 (Vict.).—Our collections of this species may be described as follows:—Pileus ¾ inch in diameter, elongated globular, then convex with an acute umbo, fibrillosely streaked, yellowish-green or dark greyish-brown, turning black with black fibrils. Gills just free or just sinuately adnexed, triangular; yellowish becoming grey or dark grey. Stem 2½ to 3½ inches high, rather fibrillose and twisted, the fibrils later becoming

blackish, pallid brownish, with scattered black cobweb-like lines, or yellowish-green, becoming hollow. Spores elliptical, almost colourless, often with apparently a watery blackish tint, 9 to 10·4 × 6 to 7 μ. Under shrubs. Lisarow, May; Neutral Bay, Sydney, May; Mosman, Sydney, June; Mount Lofty Ranges, S. Austr., June, 1917.

126. *Hygrophorus psittacinus*, Schaeff. Massee: Brit. Fung. Flora, ii., p. 341.—The following specimen seems to be best referred to this species:—Pileus up to 1 inch in diameter, somewhat conical, then convex, then expanded, dark green, browner on top, later pale olive-green, not apparently viscid, silky shining, rigid. Gills sinuate, thick, moderately distant, greyish flesh in colour. Stem 1½ inch high, attenuated upwards, reddish-brown, becoming paler, hollow. Spores pear-shaped, 7·2 to 8·5 × 5·2 μ. On the ground, Blue Mountains, May, 1914.

Marasmius.

Sect. I.—Collybiarii.

127. *Marasmius porreus*, Fr. Massee: Brit. Fung. Flora, iii., p. 155.—Pileus ¾ inch in diameter, plane or slightly depressed, striate, brown. Gills adnate, then seceding, close, dirty white. Stem slightly striate, base downy, brown. Slight foetid smell. Complete revival in water. Spores 5·2 × 2·5, 4·4 × 2 μ, one end more pointed. Amongst leaves, Manly, April, 1915. (Herb., J. B. C., Form. Sp. 50.) Though our plants resemble more Cooke's illustrations of *M. erythropus* than those of *M. porreus*, on account of the smell we place them provisionally under the latter.

128. *Marasmius alliatus*, (Schaeff.) Schröt. (*M. scorodonius*, Fr. Cooke: Handb. Austr. Fungi, No. 424; Massee: Brit. Fung. Flora, iii., p. 162.—Pileus ½ inch or larger, slightly umbilicate, coarsely but flatly grooved, dirty brownish-white to reddish-brown, paler periphery. Gills adnate, moderately crowded, many short, slightly toothed, pale cream. Stem ¾ inch high, slender, hollow, smooth, dark reddish-brown. Slight smell of garlic. Attached to fallen leaves, sometimes apparently on the ground, by a slightly bulbous base. Shed spores elongated, pear-shaped or pip-shaped, one end narrower, 8·7 to 10·3 × 3·6 to 4 μ. (D. I. C., Watercolour 32.) Neutral Bay, Sydney, February, March (spores 10·4 to 12·4 × 5·3), May; Murwillumbah, April, 1916 ([?] this species, stem finely mealy, pallid brown, spores 8 × 2·5 μ): Wiseman's Ferry, June, 1915.

The plate of *M. scorodonius* given by Cooke (Illustrs., 1125A) shows plants stouter and with caps and stems brighter rufous than our specimens.

129. *Marasmius calopus*, Fr. Massee: Brit. Fung. Flora, iii., p. 163; Cooke: Illustrs., 1125B, and Handb. Austr. Fungi, No. 425 (Q'land).—Specimens collected at Mosman, Sydney, in November, 1914, and at Manly in April, 1915, and found growing on fallen twigs, agree with Cooke's illustrations. They differ slightly from the description given by Massee in the stem being dark below and paler above. We describe our plants as follows:—Pileus up to ⅓ inch in diameter, convex, then plane or umbilicate, creamy-white sometimes with a smoky centre, somewhat sulcate-rugose, edge turned in when young. Gills adnate or adnexed, moderately distant, finely toothed, white. Stem ½ inch or more long, very slender, blackish below, then dark brown suddenly becoming whitish, sometimes almost throughout pale or dark brown, mealy tuberculose below, mealy above, attached by a minute disc. No smell (slight garlicky smell noticed in one collection). Spores rather elongated, one end more pointed, $5{\cdot}2$ to $7 \times 2{\cdot}5$ to $3{\cdot}4\ \mu$. (Miss Clarke, Watercolour 56; Herb., J. B. C., Form. Sps. 49 and unnumbered.)

130. *Marasmius equi-crinis*, F. v. M.: Grev., viii., 153; Cooke: Handb. Austr. Fungi, No. 441 (Vict., N.S. Wales, Q'land). (Syn. *Thamnomyces hippotrichoides*, C. E. Broome; *Alectoria australiensis*, Knight. Records in Ann. Rep. Bot. Gdns., Sydney, 1909 (1910), 10).—The sterile horse-hair-like mycelium is common in the Big Scrub on the Richmond River and in the Dorrigo Scrub, and also in Queensland, specimens having been collected at Enoggera, Coomera, Mount Mistake, Allumbah, Taylor Range, Kerang Creek, and Dalrymple Creek. We have also specimens collected at Futuma, in the New Hebrides. The mycelium has a superficial resemblance to certain lichens, and has been recorded under the name *Alectoria australiensis*, Knight, in Bailey's and Shirley's works, as pointed out by one of us (Cheel: Proc. Linn. Soc. N.S. Wales, xxxii., 1907, p. 475).

The following we believe to be a pileate specimen:—Pileus $\frac{1}{12}$ to ⅛ inch in diameter, convex, with about 8 coarse rugae, brown, apex smooth and a little depressed, paler with a dark central knob. Gills adnate and attached to a collar but free from the stem, distant, about 9 or 10 in number, pallid. Stem up to 4 or 5 inches long, smooth, hair-like, dark brown or black, abruptly piercing the matrix. Under shrubs on fallen wood or leaves. Mount Wilson, Blue Mountains, June, 1915 (Herb., J. B. C., Formalin Sp. 145). Extensive hair-like light-brownish mycelial threads, found covering fallen leaves, etc., in the neighbourhood of these specimens, may have been the sterile mycelium of this species, though the colour was not the dark brown or black of the stems of the cap-bearing portions.

Mycena.

Sect. II.—Basipedes.

131. *Mycena banksiae*, n. sp.—Pileus up to $\frac{1}{2}$ inch in diameter, convex, then nearly plane, viscid, sulcate-striate to near the centre, which may be depressed, covered with a pruinose downiness except in the centre, greyish-white becoming brownish, centre darker. Gills not or scarcely reaching the stem to adnate, moderately close, edges not serrate, greyish-white. Stem short, less than $\frac{1}{2}$ to $\frac{3}{4}$ inch high, shining, smooth, not definitely viscid, whitish with a slight greyish tint, attached by a small disk to the base of *Banksia* trunks, dead or living; we have also found it on dead wood other than *Banksia*. No smell. Spores subspherical, often with a large "nucleus," 6·8 to 9, 8·5 × 7, 8 × 5, 6 × 5 μ, etc. No cystidia. Mosman, April, 1915; Neutral Bay, April, 1915 (pileus conico-convex, pileus and stem with a glaucous bloom, lavender-grey, pileus widely sulcate; gills few, adnate, widely separate, greyish-white; stem swollen below); Neutral Bay, April, May; National Park, N.S. Wales, July, 1916; Bradley Head, Sydney, May, 1917. (Miss Clarke, Watercolour 52; Herb., J. B. C., Form. Sps 55 and 63.)

Pileus ad 1·25 cm. latus, convexus, deinde subplanus, viscidus, sulcato-striatus, pruinosus, subcinereo-albidus, deinde subfusco tinctus. Lamellae subadnatae ad adnatae, subconfertae, marginibus non serratis, cubcinereo-albidae. Stipes brevis, 1·25 (minus) cm. altus, nitidus, glaber, subcinereo-albidus, disco parvo. Sporae subsphericae, 6·8-8, 8·5 × 7, 6 × 5 μ.

We have named the species *banksiae* from having frequently found it growing on the trunks of various Banksias. (Pl. xxix., fig. 3.)

Sect. III.—Glutinipedes.

132. *Mycena coccineus*, n. sp.—The following beautiful little species seems referable to the genus *Mycena*. Specimens exhibit a tendency to revive when moistened, though this feature is not so definite as in the typical *Marasmius*. The gills, adnate when young, also tend to be definitely though slightly decurrent when old, suggesting *Clitocybe*, whilst their edges are rather thick, thus approaching *Cantharellus*. In Cooke's illustrations we can find no species at all resembling it. By its darker denticulate edge to the gills it is probably related to *Mycena strobilina* and *M. rosella*, though on account of the glutinous stem when moist we place it in *Mycena* under *Glutinipedes*:—Pileus $\frac{3}{8}$ inch in diameter, hemispherical to convex, occasionally dimpled or with a slight

obtuse umbo, faintly striate, when moist definitely viscid, of a dark blood-red or rich reddish-crimson colour. Gills adnate, then slightly decurrent, rather thick, moderately close, rose colour or slightly paler than the pileus, edge very slightly darker and finely denticulate. Stem 1 inch high, slender, coloured like the cap, glutinous when moist, hollow, usually attached by a small fluffy disc. On bruising the gills or stem, a little dark-red moisture appears. The colour rapidly disappears in formalin solution. Spores elongated, one end more pointed, very hard to see, 7 to 8·5 × 2·5 to 3·5 μ. Attached to small sticks and leaves in damp shady places. Mosman, Sydney, April, May, and June; Tuggerah, October; Hawkesbury River; Mount Kembla, November.

Colour tints noted:—Pileus dull carmine-lake (pl. 106, Ton 4); old blood-red (pl. 103, Ton 2).

Pileus ad 1 cm. latus, hemisphericus ad convexus, interdum umbilicatus vel subgibbosus, substriatus, viscidus, sanguineo-coccineus. Lamellae adnate, deinde subdecurrentes, subcrassae, subconfertae, rosaceo-coccineae, marginibus sanguineo-coccineis et subdenticulatis. Stipes 2·5 cm. altus, tenuis, cavus, glutinosus, sanguineo-coccineus, ad basem disco. Sporae elongatae, 7-8·5 × 2·5-3·5 μ. (Pl. xxix., fig. 4.)

SECT. IV.—LACTIPEDES.

133. *Mycena sanguinolenta*, Alb. and Schw. Massee: Brit. Fung. Flora, iii., p. 89; Cooke: Handb. Austr. Fungi, No. 116 (Vict.).—Cooke has recorded this species for Victoria and Baker (Proc. Linn. Soc. N.S. Wales, xxxi., p. 720 [1906]) for New South Wales. On several occasions in New South Wales and South Australia we have met with a *Mycena* which combines some of the characters of *M. sanguinolenta* with some of those of *M. haematopa*, Pers. It agrees with the latter in the margin of the pileus being minutely toothed and the juice being prune coloured. It grows amongst leaves or grass on the ground, however, and not on trees or stumps. In size it resembles the former, and also has a dark-red edge to the gills, which in addition are finely toothed. The colour of the juice is darker than that of *M. sanguinolenta* given in Cooke's illustration. At present we place it under *M. sanguinolenta*, as being probably the Australian species hitherto recorded as such, but it is possible that it may not be either of the two species above mentioned.

The description of our specimens is as follows:—Pileus up to $\frac{5}{8}$ inch broad and $\frac{1}{2}$ inch high, submembranaceous conico-campanulate, sometimes finally irregularly upturned,

sometimes umbonate, striate, edge of cap very finely toothed, pale brown to reddish-brown, drying paler. Gills adnate, moderately close, often irregular with connecting veins, whitish with a faint pink tinge or pallid, edges dark red or dark purple, and finely toothed. Stem up to 3 inches high, slender, shining, slightly attenuated upwards, hollow, pale to reddish-brown. A prune-coloured watery juice exudes on section or from the broken gills. Spores elongated, white, coarsely granular internally, 7 to 9 or even 12 × 5 to 7 μ. The colour may dissolve in formalin specimens. Amongst leaves under trees, grass, etc. Neutral Bay, Sydney, June, 1913; Mosman, May, 1914; Manly, May, 1915; Mount Lofty, S. Austr., July, 1914; National Park, S. Austr., June, 1917 (unusually large, the maximum sizes given above); amongst fallen bark and twigs, Craigie, Victoria, June, 1917 (E. J. Semmens, No. 39; probably this species).

Pleurotus.

134. *Pleurotus lampas*, Berk.—*Agaricus (Pleurotus) lampas*, Berk.: Hook. J., iv., 1845, p. 44; Cooke: Handb. Austr. Fungi, No. 155. Synonyms:—*Agaricus noctilucus*, Berk. (*vide* Cooke, No. 155). *Agaricus (Pleurotus) phosphoreus*, Berk.: Hook. J., vii., 1848, p. 572; Cooke: No. 157. *Agaricus (Pleurotus) illuminans*, Muell.: Linn. J., xiii., 1873, p. 157; Cooke: No. 150. *Agaricus (Pleurotus) candescens*, Muell.: Linn. J., xiii., 1873, p. 157; Cooke: No. 158; McAlpine: Linn. Soc. N.S. Wales, 1900, p. 553, pls. xxxi. and xxxii. *Panus incandescens*, B. and Br.: Linn. Trans., ii., p. 5; Cooke: No. 498; Bailey: Comp. Cat. Q'land Plants, p. 725 (= *A. Gardneri*). *Agaricus (Pleurotus)* Gardneri, as identified by Berk. and Br.: Linn. Trans., 1878, p. 399; Cooke: No. 149. (?)*Agaricus (Pleurotus) nidiformis*, Berk.: Hook. J., iii., 1844, p. 185; Cooke: No. 154.

In our opinion all of the above supposed species recorded for Australia represent examples of but one variable and very common form, of which by priority the name should be *P. lampas* (or *P. nidiformis*, if this also is the same species). Our common luminous species is undoubtedly the species described so accurately by McAlpine (*loc. cit.*).

Our reasons for considering that there are so many synonyms are as follows:—First of all, the specimens we have ourselves examined are very variable as to texture, size, and colour. Some examples are very firm, approaching *Panus*, whilst others, usually growing in shady places, are very soft and watery. The colour of the cap varies from a creamy-white in shaded examples to purplish-black and occasionally

bright fulvous-brown. Various collections might thus quite well be classified as separate species. Then, with the exception of Baron von Mueller—who only incidentally collected fungi—none of the authors quoted had, apparently, access to fresh material, and so were dependent on the notes (if any) of the collectors. In the paper in which *P. Gardneri* is recorded by Berkeley and Broome for Queensland, it is in fact definitely stated that all the species recorded by them were "unaccompanied by notes or sketches of any kind." In this paper there is no reference, as suggested by Cooke, to the fungus growing on "petioles and half-putrid fronds of palms," which obviously is taken by Cooke from the original description of the species from Brazil. There is no reference even to the species being phosphorescent. Bailey (Compr. Cat. of Q'land Plants, p. 775), evidently on higher authority, states that *Panus incandescens* = *Agaricus Gardneri*, "the large luminous fungus." As regards *P. nidiformis*, though the original description does not mention any phosphorescence, Berkeley in speaking of *P. lampas* later says it is allied to *P. nidiformis*, which is also phosphorescent. The gills in the latter are described as "ochraceous," which term might perhaps be applied to old specimens of our common species. In the original description of *P. illuminans* there seems no reason for it to have been classed by Cooke in the section with an annulate veil.

Taking everything together, therefore, we feel quite justified in this apparent "lumping," and a reference to the original descriptions will show how imperfect these are for purposes of separation. We have written to Kew to ask whether specimens of *Pleurotus lampas*, *phosphoreus*, *illuminans*, and *candescens* and *Panus incandescens* exist there, and whether the dried plants could be distinguished from each other. Through the Director of the Royal Botanic Gardens, Miss E. M. Wakefield has replied as follows:—"Specimens exist only of *Pleurotus lampas*, *P. candescens*, and *Panus incandescens*. To a person familiar with the fresh plants it might be possible to make a comparison, but the dried specimens alone are practically useless. The habit of all is very similar, but the spores found vary slightly in size, as follows:—*P. lampas* (type), 6 to 7×3 to 4 μ; *P. candescens* (type), 7 to $7{\cdot}5 \times 4$ μ; (Melbourne specimen) 7 to 10×5 to 6 μ; *Panus incandescens* (type), 7×5 μ. These are in all cases the spores obtained by scraping the gills, so that young ones would probably be included amongst them." This reply strongly supports our attitude. As regards *P. nidiformis*, Miss Wakefield, in answer to a later enquiry, said that no specimens of this species were in Kew Herbarium.

New South Wales.—We have a number of collections from the Sydney district, April to November; also specimens from Mount Wilson and Kendall, May. Spore mass sometimes pale ochraceous. Edge of pileus sometimes incurved. Spores oval, with a large "nucleus," 7 to 9 x 5 to 6 μ, usually 7·5 x 5·5 μ. In one collection made at Milson Island, Hawkesbury River, in April, the pileus was of a brilliant rufous-brown, the gills being also rufous coloured.

We have collected this "bronzed" form also at Mosman in December, 1916, spores 6·2 x 4·2 (Miss Clarke, Watercolour 142; Herb., J. B. C., Form. Sp. 280), and in May, 1917, at Mosman, Sydney, April, 1918, we found this species and *Armillaria mellea* growing together at the base of a stump.

Victoria.—Ararat (E. J. Semmens, No. 25), May, 1917.

Colour tints noted:—Pileus, in the centre tints of purplish-black (pl. 345, Ton 1), grading into, but greyer than, Parma violet (pl. 200, Ton 4); grades of colour between dark chocolate-brown (pl. 342, Ton 3), buff (pl. 309, Ton 4), mostly browner than Mars yellow (pl. 316, Ton 4), with some yellowish-tan colour (pl. 315, Tons 1 to 4) but browner; mineral-brown (pl. 339, Ton 2), the centre darker than Ton 4; Kaiser brown (Ridgway, pl. xiv.), light ochre-buff (pl. xv.), light buff (pl. xv.), and tints of light Payne's grey (pl. xlix.); shades of Payne's grey (pl. 356, Ton 4); grey (pl. 359) with a violet tint. Stem, tints of Mars yellow (pl. 316, Ton 1) at the base; tints of light Payne's grey (Ridgway, pl. xlix.).

135. *Pleurotus ostreatus*, Jacq. Cooke: Illustrs., pls. 195 and 953; Massee: Brit. Fung. Flora, ii., p. 371.—We refer the following to this species:—Pileus up to 6 inches broad and 4½ inches from before backwards, convex but nearly plane, pale smoky-brown, surface dull, edge slightly turned in. Gills close, creamy-white, anastomosing below on the short stout lateral almost obsolete stem. Spores elongated, in the mass with a slight pinkish tinge, 8·5 to 10·5 x 3·5 μ. Attached one above the other at the base of a stem of sassafras (*Doryphora sassafras*, Endl.). Hawkesbury River, November, 1916. The following is probably also this species, having been found two years previously near the same spot. These latter plants grew singly on a fallen trunk:—Pileus up to 2½ inches in diameter, convex and indented on the side nearest the stem, of a pallid stone-colour or greyish-brown, smooth but finely-punctate looking, slightly sticky, edge turned in. Stem nearly lateral, short (½ inch or under), stout, whitish to somewhat smoky. Gills moderately close, creamy-coloured, tendency to fork, some short, deeply decurrent on to the stem, where they reticulate. Flesh thick, white, rather

tough, not phosphorescent. Spore elongated, 8·5 to 8·8 × 3·4 μ, no cystidia. On upper surface of fallen trunk. Hawkesbury River, December, 1914. (Herb., J. B. C., Form. Sp. 18.)

136. *Pleurotus subostreatus*, n. sp.—Pileus up to 7 inches broad and 4 inches from before backwards, convex, becoming depressed towards its attachment, pallid whitish, matt. Gills thick, creamy-white, anastomosing near the base to form a network. Laterally attached by a short broad pallid to brown matt stem, ¾ inch long and ⅝ inch thick. Spores pear-shaped, 4 × 2·5 μ. On a fallen log, Wauchope, N.S. Wales, February, 1917. This species seems to approach *Panus* in texture. It differs from *P. ostreatus* in the definite brownish stem and in the small spores.

Pileus ad 17·5 × 10 cm., convexus, albidus, subtomentosus. Lamellae crassae, subflavo-albidae, ad basem anastomosae. Stipes ad 2 cm. longus, lateralis, brevis, crassus, pallidus ad fuscus, subtomentosus. Sporae pyriformes, 4 × 2·5 μ.

137. *Pleurotus Cheelii*, Mass.: Kew Bull., 1907, p. 122; Proc. Linn. Soc. N.S. Wales, xxxii. (1907), p. 202.—Small, white. Pileus thickly hairy, attached by the vertex. Gills radiating from the centre, moderately close, rather thick. Spores thick-walled, subspherical, 6 to 8, 7·5 × 5·8, 8·5 × 7 μ. On branches, Eden, Twofold Bay (portion of the type); National Park, N.S. Wales, July, 1916.

138. *Pleurotus striatulus*, Fr.: Icon., t. 89, f. 5; Sacc.: Syll., 1518; Cooke: Illustrs., 212B; Cooke: Handb. Austr. Fungi, No. 184 (Q'land).—Our specimens, which have been identified by Lloyd, may be described as follows:—At first minute and cup-shaped, finally more open, sometimes fan-shaped, sessile by the edge or excentrically, light grey to dark grey, slightly striate, powdery looking. Gills moderately distant, darker grey than the pileus, sometimes with a brownish tint, radiating from the downy base. At once reviving on moistening (hence really a *Panus*). On decaying branches of a living cultivated mulberry (*Morus alba*, L.), Milson Island, Hawkesbury River, June, 1913 (spores 5·5 × 3·6 μ); on a twig (spores 6·8 × 4·2 μ); on dead wood (spores 3·5 to 7 × 2 μ); Manly, April; Sydney, May; Lisarow, June; Mount Wilson, June—all the latter with subspherical spores, 4·8 to 5·5 μ (hence some doubt exists as to there being two species, with oval and subspherical spores respectively).

Lentinus.

139. *Lentinus tuber-regium*, Rumph. Lloyd: Mycol. Notes, No. 47, 1917, p. 666, fig. 959 (this collection).—Pileus up to 6 inches across, deeply infundibuliform, slightly

obscurely striate, with a lens minutely scaly, light brown to light smoky-brown. Gills close, deeply decurrent, white then with a brownish tint. Total height up to 9 inches; stem alone, above ground, 4 inches. Stem more or less equal, ⅝ inch thick, brownish, with darker fibrillose scales. Sclerotium on section pure white, 2 inches in diameter. Spores pear-shaped, 5 to 6 × 2·5 to 3 μ. On the ground amongst fallen branches of *Araucaria Cunninghamii*, Ait., Mummulgum Brush, near Casino, December, 1916. Identified by C. G. Lloyd. We have recently received from Mr. C. T. White, Government Botanist, Queensland, some undeveloped sporophores obtained by Mr. Munro Hull at Eumundi in November, 1918, on an old hickory *(Tarrietia)* stump in a banana plantation.

140. *Lentinus strigosus*, Fr. Cooke: Handb. Austr. Fungi, No. 454.—We have made several collections in New South Wales, two of which have been identified by Lloyd. The pileus is up to 2½ inches in diameter, moderately depressed, of a brownish-fawn colour, densely strigosely hairy. The decurrent gills are moderately close, entire, pallid ochraceous. The stem is short, up to ½ inch long, swollen, contracted above where the gills join, and densely strigosely hairy. Spores 4·5 to 5 × 2·2 to 2·5 μ; cystidia thick-walled, blunt to club-shaped or irregular, 26 to 52 × 8·5 to 13·8 μ. New South Wales, locality not noted; Mummulgum, near Casino, December, 1916; Wingham, November, 1916; Comboyne, September, 1918. See Proc. Linn. Soc. N.S. Wales, xxxii., p. 202 (1907), for previous records.

141. *Lentinus dealbatus*, Fr. Cooke: *loc. cit.*, No. 459 (W. Austr.).—We have specimens, obtained at Manildra, N.S. Wales, on a fallen *Callitris* log in October, 1916, which have been identified by C. G. Lloyd. The gills when young were purple-violet, but when old pallid yellowish without voilet. A few spores, 5 to 7 × 3·4 μ, seen.

142. *Lentinus fasciatus*, Berk.: Hook. J., 1840, p. 146; Sacc.: Syll., 2317; Cooke: Handb. Austr. Fungi, No. 458 (Q'land, N.S. Wales, W. Austr., Tasm.); Lloyd: Mycol. Notes, No. 55, August, 1918, p. 796.—Our specimens, which have been identified by Lloyd (No. 412, described in his Mycol. Notes) were found growing at Malanganee, near Casino, in August, 1917, in rotten wood, the mycelium being effused over the wood for several inches as a thick brown velvety layer; a few spores seen, 5 to 7·5 × 3·4 to 4·5 μ. We have also the following:—New South Wales, locality not noted; Milson Island, Hawkesbury River, April, 1915, identified by Lloyd (spores 7 × 3·4 μ, when moist the pileus straw-brown, the gills buffy-brown, adnato-decurrent, and the stem

dark brown); Stockton, October, 1915, bleached specimens (identified by Lloyd).

143. *Lentinus radicatus*, Cooke and Mass.: Grev., xiv., 118; Sacc.: Syll., 2395; Cooke: Handb. Austr. Fungi, No. 474 (Q'land).—A specimen collected on burnt soil at Milson Island, Hawkesbury River, in March, 1914, appears to be this species. This opinion has been confirmed by C. G. Lloyd. Its description is as follows:—Pileus 3 inches in diameter, upturned, reddish-tan, villous. Gills pale cream, crowded, decurrent, edge a little toothed in places. Stem 4 inches long, 1 inch thick, pale brownish-white above ground but mostly buried, the lower 2½ inches rooting and attenuated with a slightly bulbous hollow base, the rest solid, soil aggregated round the root. Spores elongated, oblique, 10·4 to 12 × 5·2 μ.

144. *Lentinus ursinus*, Fr.—Our specimens, kindly identified by C. G. Lloyd, are 1 inch or more laterally and about ¾ inch from behind forwards, the pileus fan-shaped, convex, densely pilose, dark brown. The gills are close, with the edges denticulate, pallid whitish. Laterally attached by a contracted base, sometimes developing into a short stem which is coloured and pilose like the pileus. On fallen trunks, often overlapping. Spores subspherical, 4·2 × 3·4, 3·8 μ. etc., no cystidia. Mount Wilson, June; Lisarow, December.

PANUS.

145. *Panus stypticus*, Fr. Cooke: Handb. Austr. Fungi, No. 502 (Vict.).—Specimens have been kindly identified for us by C. G. Lloyd. All the Australian specimens we have tasted lack entirely any hot or pungent taste. Spores 4·2 to 5·5 × 1·8 to 2·5 μ. Mount Wilson, June; Leura, June; Lisarow, June; between Bowral and Robertson, August; Macquarie Pass, August.

146. *Panus viscidulus*, B. and Br.: Linn. Trans., ii., 55; Sacc.: Syll., 2568; Cooke: Handb. Austr. Fungi, No. 504 (Q'land, N.S. Wales, Vict.).—Though our specimens revive perfectly on moistening, from their general appearance we feel inclined to consider them rather as a *Pleurotus* than as a *Panus*. Pileus rather small, fan-shaped, glutinous, bright tanny-brown to chestnut, edge paler and slightly striate. Gills white or pale brownish-white, decurrent, connected by veins, moderately close, edge rather thick. Stem lateral or nearly so, very short (up to ¼ inch long), villous to hairy at the base, pallid or pale brownish. Spores colourless, 6 to 7·2 × 3·4 to 4 μ. On fallen trunks amongst moisture, Mount Wilson, June, 1915. The weak formalin in which a

specimen was preserved has become dark grey and clouded, as does a solution of silver nitrate when exposed to light.

XEROTUS.

147. *Xerotus fuliginosus*, Lloyd: Letter 60, Note 338.—This species has been identified for us by C. G. Lloyd, who in his letter states that it is probably also *X. tener*, of B. and Br.; *X. Berterii*, of Mont.; *X. lateritius*, of B. and C.; *X. papyraceus*, of Berk.; and *X. Drummondii*, of Berk., mentioned in Cooke's Handb. of Austr. Fungi. The pileus is thin, fan-shaped, up to ½ inch from side to side and ¼ to ½ inch from before backwards, rugosely folded, reddish-tan when moist. The gills are distant, dark purplish-brown when moist. The stem is lateral, very short, dark brown, and finely villous. Young plants are bright rufous with hymenium a deep reddish-brown. Shed spores 10·4 to 12 × 7 μ. On fallen twigs and sticks in brush forests, etc. Helensburgh (A. A. Hamilton), October, 1913; Bulli Pass, May, 1914, and November, 1917; Blue Mountains, November, 1914 (spores 8·5 × 4·2 μ); National Park, July, 1916; Mosman, December, 1916.

LENZITES.

148. *Lenzites abietina*, Fr.: Epicr., p. 407; Cooke: Illustrs., pl. 1146A; Massee: Brit. Fung. Flora, ii., p. 306; Cooke: Handb. Austr. Fungi, No. 529 (Q'land, S. Austr.).—The gills of one of our specimens, identified by Lloyd, when moist were pale brown and pruinose with spores, slightly toothed and folded; the spores were colourless, elongated, 8·5 to 10·5 × 5 μ (slightly larger than the measurements, 7 to 8 × 4 μ, given by Massee for European specimens), no cystidia; extending longitudinally many inches; on a fallen log near Hill Top, N.S. Wales, October, 1913. We also have the following:—Narromine, May, 1914; on fallen log, Milson Island, Hawkesbury River (sometimes effused, sometimes reflexed; pileus dark brown, growing edge yellow-brown to pallid; gills chocolate-brown; spores 8·5 to 10·4 × 4 μ), February, 1915, identified by Lloyd (No. 325). This species(?), on fallen *Callitris* log, Pilliga Scrub, November, 1916, identified by Lloyd (No. 328), who says, "Compared to the European plant, it is much thinner, more rigid, and has distinct pubescent zones, not seen on the European plant: it should have a name."

149. *Lenzites ungulaformis*, Berk. Lloyd: Mycol. Notes, No. 56, October, 1918, page 811.—Lloyd has published the above note on our specimens, which were obtained at Malanganee, near Casino, in August, 1917. He thinks that this

"species," described by Berkeley from the Southern United States, is not a true species, but an aberrant form of *L. betulina*. He says, "The context is white, the gills typically those of the common *Lenzites betulina*, but the upper surface is different. It is white, not pubescent, nor zoned, but glabrous and rugulose." We have also collected a specimen at Lorne, near Kendall, September, 1918.

150. *Lenzites striata*, Swartz. Fr.: Epicr., i., p. 406; Sacc.: Syll., 2653; Cooke: Handb. Austr. Fungi, No. 531 (Q'land, Vict.).—On fallen *Callitris* log, Narrabri, November, 1916 (identified by Lloyd, No. 266). Lloyd says of these specimens that they are not exactly the common plant of the American tropics, but close to it. "The colour, gills, and general shape are the same, but the surface is harder and more zonate."

151. *Lenzites saepiaria*, Fr.: Hym. Eur., 494; Cooke: Illustrs., pl. 1146A; Sacc.: Syll., 2636; Cooke: Handb. Austr. Fungi, No. 528 (Vict.).—Specimens identified by Lloyd (No. 219) from Manildra, October, 1916, on old *Callitris* stump.

152. *Lenzites Beckleri*, Berk.: Linn. Journ., xiii., 161; Sacc.: Syll., 2664; Cooke: Handb. Austr. Fungi, No. 536 (N.S. Wales, Q'land).—Wingham, Nov., 1916, identified by Lloyd (No. 331) as doubtfully this species. He adds that this specimen has the surface and context of *L. Beckleri* with the pores of *L. repanda*. "The gills of *L. Beckleri* are more lamellate, like those of *L. betulina*, but I put more stress on the context nature and surface of this group of plants than on the hymenial configuration. In nature of context and surface it approaches *Trametes lactinea*."

153. *Lenzites repanda*, Mont. Fr.: Epicr., 404; Sacc.: Syll., 2688; Cooke: Handb. Austr. Fungi, No. 542 (Q'land, N.S. Wales).—Eumundi, Q'land, January, 1911 (J. Stair: identified by Lloyd, No. 329); Murwillumbah, April, 1916 (spores 7 x 2·5 to 3 μ: Lloyd, No. 330); Malanganee, August, 1917; Kendall, May, 1917; Comboyne, September, 1918. We have also specimens from Mango Island, Suva, Fiji, 1918 and 1919 (Mrs. Lucas).

154. *Lenzites Muelleri*, Berk. *Daedalea Muelleri*, Berk.: Grev., xix., 93; Cooke: *loc. cit.*, No. 868, Vict. (aberrant *L. repanda*, Lloyd in letter).—Comboyne, September, 1918; identified by Lloyd (No. 512). Lloyd in a note says that *L. repanda*, unlike *L. flavida*, is remarkably uniform in hymenial form, but that our specimen is so different from the usual appearance that Berkeley might be excused for naming it a new species as *Daedalea Muelleri*. He adds that it must not

be confused with *Trametes Muelleri*, which may also be a variant, but has small round pores and is more frequent and constant.

155. *Lenzites bicolor*.—On a dead stump of *Callitris robusta*, R. Br., Pilliga Scrub, October, 1918; identified by C. G. Lloyd (No. 509). In a note on these specimens Lloyd says that they are the same as regards context-colour and gills as *Lenzites abietina*, but the surface is pale (almost white) and of a different colour to the context, and there are dark zones on the surface, where this pale surface layer is undeveloped. The upper surface view is the same as that of *Polystictus Friesii*. Lloyd mentions that this is the only *Lenzites* he has seen where the context-colour and surface layer are not uniform.

POLYPORACEAE.

Boletus.

156. *Boletus romanus*, Ottav.—The following species, of which we have had prepared a coloured drawing, resembles so closely the figure of "*Boletus Romanus*, Ottav.," given on pl. xv. of Badham's work "On the Esculent Funguses of England," that we consider, for the present at least, that we are justified in calling it by this name. Unfortunately all that Badham says of the species is as follows:—"The *B. Romanus* was first described by Ottaviani, who obligingly sent a coloured drawing of it (from which the present figure has been taken), and a minute description, which I have unfortunately mislaid. The site of this *Boletus* is on ground where wood has been burnt, and it is brought by the 'Carbonari' in autumn when they come with their charcoal to Rome." We do not find the name in Fries. Our plants were described when gathered as follows:—Pileus convex, splashed with madder-brown in fibrils, yellowish between. Pores rounded near the stem, very fine, rich sulphur-yellow. Stem stout, $2\frac{1}{2}$ inches high, 1 inch broad below, sulphur-yellow with slightly darker raised flecks. Flesh showing a tinge of blue in places. Spores "mummy-shape," greenish, $10{\cdot}4 \times 3{\cdot}4\ \mu$. Under *Casuarina*, North Bridge, Sydney, April, 1916.

157. *Boletus scarlatinus*, n. sp.—Pileus usually $1\frac{1}{4}$ to 2 inches in diameter, but after heavy rains occasionally reaching $3\frac{3}{4}$ inches across, convex to nearly plane, irregular, smooth, somewhat viscid when moist (leaves may adhere to the separable cuticle), brilliantly but often irregularly coloured with tints of madder red, deep-orange cadmium, scarlet, crimson or yellowish buff. Pores adnate, rarely with a slight sulcus round the stem or slightly decurrent, in large specimens

the tubes 3/16ths to 5/16ths inch deep, rather large and irregular, rarely somewhat sinuous or gill-like near the stem, pale yellowish flesh or dingy yellow, becoming browner when old. Stem usually about $1\frac{1}{4}$ to $1\frac{1}{2}$ inch high, in large specimens 3 inches high, slender or stout ($\frac{1}{2}$ to $\frac{3}{4}$ inch thick), conical or even a little bulbous below, often excentric, sometimes slightly striate, whitish, yellowish or with tints of the pileus in places. Flesh white. Sometimes subcaespitose. Spores elliptical (not "mummy-shaped"), pale yellowish, slightly curved, one end a little broader, 5·5 to 8·5 (occasionally to 11) × 3·4 to 4·2 μ. Neutral Bay and Mosman, February to May (Miss Clarke, Watercolour 202); North Bridge, April (Miss Clarke, Watercolour 95); National Park, N.S. Wales, May.

Colour tints noted:—Pileus fiery red (pl. 80, Ton 4) when wet, dull and more crimson when dry, to reddish chrome (pl. 51, Ton 4) at edge; orange cadmium (pl. 85, Ton 4); deep-orange cadmium (pl. 50, Ton 1); scarlet (pl. 49, Ton 4); dull madder-red (pl. 97, Ton 4); carrot red (Capuchin lake) (pl. 55, Ton 2); blood-red brown (faint) (pl. 337, Ton 1); cherry red (cerise) (pl. 91, Ton 4); nearly yellowish-buff (pl. 310, Ton 1); yellowish-white (pl. 13, Ton 4); yolk yellow (pl. 24, Ton 1). Pores, in one specimen, a little greyer than purplish-white (pl. 6, Ton 3). Stem, sunflower yellow (light cadmium yellow) (pl. 23, Tons 1 and 2) with tinges of red; primrose yellow (pl. 19, Ton 3) in upper part; deep cadmium yellow (saffron yellow) (pl. 48, Ton 1); orange cadmium (pl. 85, Ton 2); yellowish-white (pl. 13, Ton 4) at the top; a little brighter than honey yellow (pl. 35, Ton 1) tinged with faint brown lake (pl. 336, Ton 1).

Pileus 3 ad. 5 cm. latus, interdum ad 9·3 cm. latus, convexus ad subplanus, irregularis, subviscidus, scarlatinus, coccineus aut aurantiaco-scarlatinus. Tubi adnati, 5-7 mm., flavido-albidi. Stipes 3 ad 3·75 cm. altus, interdum ad 7·5 cm. altus, subtenuis aut crassus (1·2-1·9 cm. latus), colore flavo, flavo-pallido aut aurantiaco-scarlatino tinctus. Sporae ellipticae, 5·5-8·5 × 3·4-4·2 μ, interdum 8·5-11 × 3·8-4·2 μ.

This species resembles *Boletus Ballouii*, Peck (N. York State Mus., Mus. Bull. 157, 1911, p. 22, pl. viii., figs. 1-5), but the colour is much more brilliant than in his illustrations. The general description and spore shape and spore measurements show that the species are closely allied. The species may perhaps also be related to *B. sanguineus*, With. (Masse: Brit. Fung. Flora, i., p. 266), though there is no change in colour in the flesh when cut. (Pl. xxvii., figs. 5 and 6).

Strobilomyces.

158. *Strobilomyces pallescens*, Cooke and Mass.: Grev., xviii., 5; Cooke: Handb. Austr. Fungi, No. 575, fig. 51 (Q'land).—The base of the stem often bulbous; flesh turning bluish when cut, the blue later disappearing, flesh of stem reddish on section; upper part of stem sometimes tinted with rosy purple; spores 17 to 22·5 × 6 to 8·5 μ, longitudinally rugose; usually at the base of trunks, sometimes with pale fawn-tinted mycelium attached to leaves, etc. Frequent at Neutral Bay, Sydney, May; Chatswood (Miss Clarke, Water-colour No. 148); Narrabeen, March; Milson Island, Hawkesbury River, March; Kendall, December.

159. *Strobilomyces floccopus*, Rost. Vahl: Ic. Pl. Fl. Dan., t. 1252; Sacc.: Syll., 4835; Cooke: Handb. Austr. Fungi, No. 579 (Q'land).—The following, from the only description available to us, that in Cooke's Handbook, seems to be this species. We have not noticed, however, that the veil is appendiculate as a ring, and the stem in our specimens can hardly be called lacunose above. There is no reference in Cooke's description as to whether the epispore is smooth or rough (as in our specimens). *S. velutipes*, Cooke and Massee (Cooke, No. 580), resembles our plants to some extent from the description, but its spores are definitely stated to be "even." Pileus up to 3 inches in diameter, almost hemispherical, then convex, edge turned in and extending slightly beyond the pores and sometimes showing fragments of the veil, soft to the touch, covered with a cotton-wool-like villosity with fine warts, sometimes presenting the appearance of adpressed dark-brown imbricate cotton-wool-like scales, dark sooty-brown to reddish-black, sometimes paler at the periphery. Pores adnate or slightly rounded near the stem and gradually separating from it or tending to be slightly decurrent, somewhat irregular, medium-sized, up to ⅜ inch deep, creamy to pallid white, turning dark brown or blackish. Flesh up to ⅝ inch thick, a thick cotton-wool-like layer on the surface, the flesh and tubes at once turning red, then blackish, when cut. Stem up to 4 inches high and ¾ inch thick, equal or sometimes attenuated upwards or downwards, with a cotton-wool feeling from shaggy remains of the veil or finely strigosely scaly or villose, in one specimen splitting and the separated part revolute, in the upper part sometimes with a network derived from the pores or breaking into areolate dark portions showing the white flesh between, base sometimes slightly bulbous, pallid to brownish and dark sooty-brown, solid. Spores subspherical to broadly pear-shaped, rough (mulberry-like), 7 to 10·4, 8·5 × 7 μ. At the roots of trees or stumps. Neutral Bay, April, 1915; Bradley Head, Sydney,

April, 1919; Lisarow, May, 1918 (Miss Clarke, Water-colour 70; Herb., J. B. C., Form. Sp. 98); Krambach, near Gloucester, January, 1918.

Colour tints noted:—Pileus reddish-black (pl. 344, Tons 1 and 2).

Polystictus.

160. *Polystictus elongatus*, Berk.: Hook. J., 1842, p. 149; Sacc.: Syll., vi., 5640; Cooke: Handb. Austr. Fungi, No. 750 (Vict., Q'land).—Mount Wilson and Katoomba, June; Leura, November; Somersby Falls, near Gosford, May; Hawkesbury River, August and December (spores elongated, 5 × 2 μ)—all in New South Wales. Specimens have been identified by Lloyd.

161. *Polystictus meleagris*, Berk. Lloyd: Letter 65, Note 577.—Specimens collected in Mummulgum Brush, near Casino, in December, 1916, have been identified by C. G. Lloyd (No. 257).

162. *Polystictus badius*, Berk. Lloyd: Letter 67, Note 666.—Specimens, sent to us by Dr. Leighton Jones from Darwin, have been identified by C. G. Lloyd (No. 317).

163. *Polystictus ochraceo-stuppeus*, Lloyd: Letter 63, 1916, Note 464.—Petersham, Sydney, April, 1912 (T. Steel). Identified by C. G. Lloyd in the above reference, who thus describes it:—"Pileus erect, confluent, somewhat rosette form. Surface ochraceous, soft tomentose, not zoned. Context dry, soft, pinky, ochraceous. Pores minute, adustous. Cystidia none. Spores not known to me. In general colour much like *Polystictus ochraceus*, but context not of the same nature. The soft, pinky context is similar to species of *Trametes*, as *T. lactinea*, rather than to other *Polystictus*. We would put it in the section with *Polystictus occidentalis*, though its context relations are entirely different. The specimens, while well developed, grew on an ash floor, and the form, like the rosette form of *Polystictus versicolor*, when growing on top of a log, is probably not the normal form."

164. *Polystictus occidentalis*, Klotzsch. Cooke: Grev., xiv., 85 (1886), and Handb. Austr. Fungi, No. 794; Sacc.: Syll., vi., 5843 (Vict., Q'land, N.S. Wales, S. Austr.).—Darwin, 1917 (Dr. Leighton Jones); identified by C. G. Lloyd (No. 316).

165. *Polystictus (Trametes) Persoonii*, Mont. Cooke: Handb. Austr. Fungi, No. 791 (Vict., Q'land, New Guinea).—We have two collections, identified by Lloyd (Nos. 140 and 270), one from Mummulgum Brush, near Casino, N.S. Wales, December, and one from Murwillumbah(?) Of the former Lloyd says "pileus usually of a brighter colour. Pores somewhat irpicoid."

166. *Polystictus subfulvus*, Berk.—In identifying specimens for us, Lloyd says he thinks they are the same as the Brazilian plant. We have collected it at Kurrajong Heights in August, 1912 (spores(?) 3·5 × 1·7 μ), and at Leura, June, 1916.

167. *Polystictus flavus*, Klotz. Lloyd: Mycol. Notes, iii., p. 450 (1911-12), and Letter 67, Note 680.—Specimens collected on a fallen log near Nattai River, *via* Hill Top, in October, 1913 (spores 6·2 to 8·5, usually 7, × 3·8 μ), were considered by Lloyd as a daedaloid form of *P. flavus*, having "the same context colour and microscopic structure (hyaline cystidia and spores)." We have also specimens from Narrabri, March, 1914 (spores 7 to 8·5 × 3·5 μ).

168. *Polystictus versicolor*, L.—Cooke: Handb. Austr. Fungi, No. 774 (Vict., N.S. Wales, Q'land, Tas.).—New South Wales: Mount Wilson, June, 1915; The Rock, July, 1917; Narrabeen, April, 1915; Hornsby, July, 1916; Neutral Bay, July, 1917 (confirmed by Lloyd, No. 386, who says "a little pale but very close to the usual colour"); Dorrigo, January, 1918; on decaying trunk of willow (*Salix caprea*, L.), Moss Vale, June, 1919; Myall Lakes (Mr. Gross), May; destroying a telegraph post, Mosman, May.

Tasmania: Wilmot (A. M. Lea), January, 1918.

Victoria: C. Brittlebank (No. 1), 1919.

169. *Polystictus sanguineus*, L.. Cooke, *loc. cit.*, No. 746; Clel. and Cheel: Jour. Proc. Roy. Soc. N.S. Wales, li., 1917, p. 485, No. 30.—Comboyne, August, 1915; Mango Island, Suva, Fiji, 1919 (Mrs. Lucas).

170. *Polystictus cinnabarinus*, Jacq. Cooke: *loc. cit.*, No. 770; Clel. and Cheel: *loc. cit.*, p. 486, No. 31.—New South Wales: Barellan, August, 1918; The Rock, July, 1917; Dungog, November, 1916; Bellinger River (Mr. Smithers), June, 1919; Narrabri, November, 1916; Myall Lakes (Mr. Gross), May.

Victoria: Ararat (E. J. Semmens, No. 6).

Queensland (on *Acacia aulalocarpa*, A. Cunn. (?), May, 1918 (E. Swain); on scrub-box (*Eucalyptus*, sp.), Gympie, June, 1918 (E. Swain).

South Australia: Port Elliot, August, 1918 (D. I. C.).

Western Australia: Guildford, December, 1918 (E. C.).

171. *Polystictus cervino-gilvus*, Jungh.; recorded for Australia in Cooke, *loc. cit.*, No. 789, as *P. peradeniae*, Berk. and Br., which Lloyd states is a synonym.—Malanganee, 25 miles west of Casino, August, 1917, identified by Lloyd (Nos. 388 and 418).

Polyporus.

172. *Polyporus (Petaloides) Clemensiae*, Murr. Lloyd: Letter 65, Note 574, and Letter 68, Note 734; place after *Polyporus rubidus*, No. 12, Sect. 15, in Clel. and Cheel, Jour. Proc. Roy. Soc. N.S. Wales, li., p. 481.—Specimens obtained at Barron Falls, Kuranda, Queensland (Mrs. Fraser), in September, 1917, have been identified by Lloyd (No. 429), who refers to them in Note 734. He says the species is close to *P. rubidus*, and is perhaps the basis of the record of the latter species in Cooke's Handbook (No. 640).

173. *Polyporus (Merismus) anthracophilus*, Cooke. Cooke: Handb. Austr. Fungi, No. 622; Clel. and Cheel: *loc. cit.*, p. 488, No. 39.—Pileus pallid to dark smoky-brown, spores ([?] conidial) $5 \times 3{\cdot}4$, 6 to 7×3 μ, at base of a trunk, National Park (S. Austr.), June, 1917. These specimens were identified by Lloyd, who says that this is the plant so named by Cooke, but he thinks that it is better referred to *Polyporus giganteus*, Pers., as there is no real difference, though the Australian plant is darker and harder.

174. *Polyporus (Merismus) sulphureus*, Fr. Cooke: *loc. cit.*, No. 624 (Q'land, Tas.); Cleland and Cheel: *loc. cit.*, p. 488, No. 42.—In large masses at or near the bases of trees, Macquarie Pass, August, 1917; identified by Lloyd (No. 410).

175. *Polyporus (Merismus) rosettus*, Lloyd: Mycol. Notes, No. 43, 1916, p. 601; Cleland and Cheel: *loc. cit.*, p. 490, No. 47.—At the base of an old stump, National Park (S. Austr.), June, 1917, spores $4{\cdot}2 \times 2{\cdot}5$ μ; identified by Lloyd (No. 350).

176. *Polyporus (Spongiosus) rufescens*, Pers. Cooke: *loc. cit.*, No. 600; Clel. and Cheel: *loc. cit.*, p. 490, No. 48.—At the base of a cultivated olive, numerous white spores, $5 \times 3{\cdot}4$, Beaumont, near Adelaide, April, 1917; identified by Lloyd (Nos. 300 and 443).

177. *Polyporus (Spongiosus) Albertini*, Mueller. Lloyd: Stipit. Polyporoids, p. 160, and Letter 67, Note 662; place after *P. tomentosus*, p. 491, No. 51, in Clel. and Cheel, *loc. cit.*—This species closely resembles *P. Schweinitzii* in appearance, but microscopically has brown spores. Lloyd has identified specimens for us. Taree district (H. Lyne), numerous brown, slightly irregular spores $8{\cdot}5 \times 5{\cdot}5$ μ, January, 1917 (Lloyd, No. 295); Kendall, at base of tree, numerous brown oval spores 8 to 9×6 to $6{\cdot}8$ μ, March, 1918 (Llyod, No. 442).

178. *Polyporus eucalyptorum*, Fr. Cooke: *loc. cit.*, No. 656; Clel. and Cheel: *loc. cit.*, p. 522, No. 120.—On fallen trunks, Kendall, March, 1918, spores broadly pear-shaped, $8{\cdot}5$ to $10{\cdot}4 \times 6{\cdot}8$ μ.—colour tints noted, pores

yellowish-white (Dauthenay, pl. 13, Ton 4), cap tinted with pale otter brown, paler than otter brown (pl. 354, Ton 1); pellicle on pileus, greyish-brown with minute punctate spots, pores bright yellow, 1/16th inch deep, Bradley Head, Sydney, May, 1918; on underside of dead fallen trunk, Berrima, July, 1919, spores 8·5 x 6 μ—colour tint noted, pores near massicot yellow (Ridgway, pl. xvi.).

179. *Polyporus gilvus*, Schw. Cooke: Handb. Austr. Fungi, No. 641; Clel. and Cheel: Jour. Proc. Roy. Soc. N.S. Wales, li., 1917, p. 533, Sect. 91, No. 143.—Near Wauchope, February, 1917, identified by Lloyd; Bulli Pass, November, 1917; Myall Lakes (Mr. Gross), May.

180. *Polyporus gilvus*, var. *scruposus*, Fr. Cooke: *loc. cit.*, No. 643; Clel. and Cheel: *loc. cit.*, p. 534, Sect. 91, No. 143A.—Barron Falls, Kuranda, Queensland, September, 1917 (Mrs. Fraser).

181. *Polyporus pertusus*, Fr. (as *Trametes*). Llloyd: Mycol. Notes, No. 58, 1917, p. 827.—Barron Falls, Kuranda, Queensland, September, 1917 (Mrs. Fraser), setae brown, sharp-pointed, 25 to 34 x 7 μ at base; identified for us by C. G. Lloyd (No. 426). Speaking of this specimen in the note above cited, Lloyd states that this species belongs to the "gilvus" group, having the same colour, spores, and setae, but the upper flesh is soft and spongy, as in *P. fruticum*. He considered it a very rare plant.

182. *Polyporus Patouillardii*, Rick. Lloyd: Letter 68, Note 738; Clel. and Cheel: *loc. cit.*, p. 539, Sect. 95, No. 154.—Bribie Island, Moreton Bay, Queensland, spores yellow-brown, 5 x 3·4 μ, no setae—Lloyd in determining this (No. 499) adds "this (determination) does not seem exactly right to me"; Warren, N.S. Wales, on decaying trunk of a large specimen of *Acacia salicina*, var. *varians*, Benth., spores 7·2 x 6 μ—confirmed by Lloyd; Malanganee, near Casino, August, 1917, spores brown, 4·8 x 3·4 μ, no setae—identified by Lloyd (No. 415), Lloyd in the above note now thinks that the species grades into *P. dryadeus*, Fr., the Australian plants being midway between the two with dark spores but no setae-like hyphae.

183. *Polyporus fruticum*, Berk. Cooke: *loc. cit.*, No. 649; Clel. and Cheel: *loc. cit.*, Sect. 96, No. 155.—On shrubs, about 1 foot or so from the ground, Malanganee, near Casino, August, 1917—identified by Lloyd (No. 397); Barron Falls, Kuranda, Queensland (Mrs. Fraser), September, 1917—identified by Lloyd (No. 434).

184. *Polyporus sessilis*, Murr.; in Clel. and Cheel: *loc. cit.*, under Sect. 98B.—Barron Falls, Kuranda, Queensland, September, 1917 (Mrs. Fraser); Lloyd in identfying these

(No. 469) adds that this is really a sessile *P. lucidus*. We have also specimens from Mango Island, Suva, Fiji (Mrs. Lucas), 1918, spores brown, very slightly rough, 12 × 6·5 μ.

Fomes.

185. *Fomes robustus*, Karsten. Lloyd: Synop. Genus Fomes, p. 242, fig. 589; Clel. and Cheel: Jour. Proc. Roy. Soc. N.S. Wales, li., 1918, p. 509 (No. 101); Clel. and Cheel: Forest Comm. N.S. Wales, Bull. 12, 1918, p. 9, pl. ix.—Syns. *Fomes Robinsoniae*, Murrill, and *F. squarrosus*, Wilson; Clel. and Cheel: Journ. Proc. Roy. Soc. N.S. Wales, li., 1918, p. 514 (No. 106); *F. setulosus*, Petch (form with abundant setae), Clel. and Cheel: *loc. cit.*, p. 511 (No. 102).—Lloyd has now come to the conclusion (Mycol. Notes, 50, p. 713) that *F. setulosus* is a setae-bearing form of *F. robustus*. *F. Robinsoniae* and *F. squarrosus* he considers also to be *F. robustus*. In Australian specimens we note slight differences in the depth of colour of the context in different collections and even in the same individual plant. In some specimens we have not found setae, in others we have met with a few, whilst occasionally they are abundant. It may be convenient to retain the name *F. setulosus* for the latter.

Queensland: Darling Downs, 20 miles from Toowoomba (Miss Butler), December, 1917.

New South Wales: On a smooth-barked eucalypt, probably *E. saligna*, Sm., near Robertson, August, 1917: at base of *Angophora lanceolata*, Cav., Cremorne, Sydney, spores colourless, subspherical, 7 μ, setae not seen, August and November; on *Eucalyptus botryoides*, Sm., Bradley Head, Sydney, spores subspherical, 6·8 μ, setae not seen, April, 1918; on *Casuarina suberosa*, Ott. et Dietr., Manly, November, 1916; on *Casuarina* sp., between Telegraph Point and Kempsey, January, 1918; on *Casuarina Luehmanni*, R. T. Baker, Pilliga Scrub, Narrabri (identified by C. G. Lloyd, No. 303), November, 1916; on dead *Banksia*, Berrima, July, 1919.

South Australia: On *Eucalyptus viminalis*, Lab., National Park (identified by Lloyd, No. 424), spores colourless, subspherical, 5 to 7 μ, a few scattered brown acuminate setae with broad bases.

186. *Fomes conchatus*, Pers. Lloyd: Syn. Gen, Fomes, p. 244; Clel. and Cheel: *loc. cit.*, p. 512 (No. 103). Kendall, August, 1918; near Wauchope, February, 1917 (identified by Lloyd, No. 305).

187. *Fomes densus*, Oleson. Lloyd: Syn. Gen. Fomes, p. 245; in Clel. and Cheel, *loc. cit.*, place after *F. conchatus*, No. 103, p. 512.—This Lloyd describes as a thick heavy form

of *F. conchatus.* He has identified specimens for us (No. 448) found destroying telegraph posts at Cremorne, Sydney, in February and June, 1918; small brown setae present, the context suggesting a Fomes form of *Polyporus gilvus.*

188. *Fomes roburneus*, Fr. Lloyd: Syn. Gen. Fomes, p. 246; in Clel. and Cheel, *loc. cit.*, place after *F. igniarius*, No. 105, p. 514.—Lloyd considers this species as a form of *F. igniarius* with abundant setae and a hard, black crust. He has identified a specimen for us (No. 428) found on a fallen log at Kendall, with very numerous brown setae projecting 17·4 μ, December, 1917.

189. *Fomes rimosus*, Berk. Lloyd: Syn. Gen. Fomes, p. 248; Clel. and Cheel: *loc. cit.*, p. 515 (No. 107).—Queensland: Well-camp, Toowoomba (Miss I. H. Cameron), identified by Lloyd (No. 489), spores brown, 7 × 5·5 μ, August, 1918; Bribie Island, Moreton Bay, spores 5·2 × 3·4 μ, September, 1918; on ironbark (*Eucalyptus paniculata*, Sm.), Redbank, Brisbane, spores yellow-brown, 6·8 × 5·5 μ, September, 1918.

190. *Fomes badius*, Berk. Lloyd: Syn. Gen. Fomes, p. 249; in Clel. and Cheel, *loc. cit.*, place after *F. rimosus*, var. *Niaoulii*, No. 107A, p. 115.—Lloyd defines this as a large-spored *F. rimosus.* He has identified two collections for us. No. 310 is from South Australia, spores subspherical, dark yellow-brown, 6·5 × 5 μ, no setae seen; No. 466 on wattle (*Acacia aulalocarpa*, A. Cunn. [?], Gympie, Queensland (E. Swain), May, 1918.

191. *Fomes pseudosenex*, Murr. (?). Lloyd: Syn. Gen. Fomes, p. 255; in Clel. and Cheel, *loc. cit.*, place after *F. pullus*, No. 110, p. 516; Lloyd: Letter 65, Note 546.—We have received from Mr. E. Swain two specimens of apparently the same species, one obtained in May, 1918, and one in September, found growing on hoop pine (*Araucaria Cunninghamii*, Ait.) on Bunya Mountains, Queensland. One of these has been identified by Lloyd (No. 493) as probably *F. pseudosenex*; the pores were minute and yellowish, and the bracket was 4 inches laterally and high and 2½ inches antero-posteriorly. The other specimen was larger, weighing 5 lb. 2 oz., and measuring 10 inches laterally, 7 inches high, and 8 inches antero-posteriorly; it showed the presence of *brown setae* and occasional brown spores, 5·5 to 6·5 × 3·8 μ, one apparently 8·5 × 5 μ.

192. *Fomes yucatensis*, Murr. Lloyd: Syn. Gen. Fomes, p. 257; Clel. and Cheel: *loc. cit.*, p. 516 (No. 112).—Dorrigo, identified by Lloyd (No. 446), spores brown, subspherical, 4 to 5 μ, numerous dark-brown setae, acuminate, with dilated bases, 34 to 50 × 8·5 μ; on *Acacia aulalocarpa*,

A. Cunn.(?), Gympie, Queensland (E. Swain), spores brown, 6 to 7 μ, a few acuminate setae.

Poria.

193. *Poria callosa*, Fr.: Syst. Myc., i., p. 382; Sacc.: Syll., 5964; Cooke: Handb. Austr. Fungi, No. 820 (Q'land).—Mr. C. White, Government Botanist, Queensland, has kindly given us a portion of the specimen identified as this species for F. M. Bailey, and referred to in Cooke under No. 820. It bears a note, "Bailey's No. 430, on rafters of a verandah, Brisbane." In April and June, 1917, we obtained at Burnside, Adelaide, on the rotting trunk of *Pinus*, sp., portion of a *Poria* which had dried a reddish-brown. This colour is a little deeper and redder than that of Bailey's specimen, but the plants seem otherwise identical.

Another species apparently, which has dried a dark brown, is like Bailey's specimen, save that the pores are twice as big. It formed an easily separable crust under the boards of a damp kitchen sink, Neutral Bay, Sydney, October, 1916.

194. *Poria vaporaria*, Fr.: Syst. Myc., i., p. 382: Sacc.: Syll., 6035; Cooke: Handb. Austr. Fungi, No. 829 (Q'land, Vict., W. Austr., Tas.).—The following agree with an American specimen kindly sent to us by C. G. Lloyd. On dying trunk, Neutral Bay, Sydney, August, 1912; Moss Vale, November, 1918; Ararat (A. J. Semmens, No. 10). We have a number of other specimens, probably of several species, resembling but not identical with Lloyd's specimen.

Trametes.

195. *Trametes lactinea*, Berk.: Ann. Nat. Hist., x., 371; Sacc.: Syll., 6204; Cooke: Handb. Austr. Fungi, No. 849 (Q'land, N.S. Wales, S. Austr.).—Specimens have been identified for us by C. G. Lloyd. Milson Island, Hawkesbury River, July; Tuggerah, October: Kew, March, pores turn reddish on bruising when fresh (Lloyd, No. 343); Malanganee, near Casino, August, pores turn reddish on bruising; on ironbark, Gympie, Queensland, June, red marks from bruising when fresh (E. Swain). See also Proc. Linn. Soc. N.S. Wales, xxxii., p. 203 (1907), for previous record.

196. *Trametes protea*, Berk.—Lloyd has identified specimens for us (No. 438), growing on a fence at Kendall, December, 1917; he considers the species as better placed under *Polystictus*. We have also collected specimens on dead wood on Bribie Island, Moreton Bay, September, 1918.

197. *Trametes semitosta*, Berk. *Fomes semitostus*, Berk., in Lloyd, Syn. Gen. Fomes, p. 220; Lloyd: Letter 68, Note

736.—In identifying specimens (No. 432) for us, found on a fallen trunk at Kendall in December, 1917, Lloyd (Letter 68, Note 736) says as follows:—"In my Fomes Synopsis as a *Fomes*, but really a *Trametes*. The type is a thin plant, hardly ½ cm. thick, but this specimen is 2 cm. thick. The surface is not of as dark a colour as the type, but no doubt will be when it gets to be as old as the type. 'Half-toasted' is a good name for it now, but not for the type now."

HYDNACEAE.

Hydnum.

198. *Hydnum rufescens*, Pers.: Sym., p. 555; Massee: Brit. Fung. Flora, i., p. 152. A colour form of *H. repandum*, L. (Lloyd).—Lloyd has identified specimens for us under this designation. The flesh of the Australian species turns reddish-brown when injured. Neutral Bay, Sydney, June, 1912 and 1916; Newington, Sydney, June, 1914; Milson Island, Hawkesbury River, July, 1912; National Park, New South Wales, July, 1916, Spores 3·5 to 5·5 μ, spherical to oval.

199. *Hydnum coralloides*, Scop.: Carn., 2, p. 472; Massee: Brit. Fung. Flora, i., p. 156; Cooke: Handb. Austr. Fungi, No. 925 (Q'land).—The identification has been confirmed for us by C. G. Lloyd. Mount Irvine, Blue Mountains, January, 1915 (G. P. Darnell Smith), spores subspherical, 3·5 μ; on side of a trunk, Mount Wilson, Blue Mountains, June, 1915, spores 3·8 × 2·2 μ.

200. *Hydnum ochraceum*, Pers. Sacc.: Syll., 6725; Cooke: Handb. Austr. Fungi, No. 928 (Vict., Q'land).—Specimens, identified by Lloyd (No. 391), were collected at Lismore in August, 1917.

201. *Hydnum Muelleri*, Berk.: Linn. J., xvi., 167; Sacc.: Syll., 6727; Cooke: Handb. Austr. Fungi, No. 929 (N.S. Wales, Q'land).—Specimens collected at Lisarow in June, 1916, were sent to C. G. Lloyd, who, in referrring to this species, adds:—"I judge from my photograph of the type. . . . The plant is very close to *H. rawakense*, Pets. I am not sure if it is distinct. It has similar cystidia on the teeth. It is more conchoid and the teeth are not so dark."

202. *Hydnum zonatum*, Batsch.: F. 224; Massee: Brit. Fung. Flora, i., p. 154.—Specimens collected on the underside of a fallen trunk at Mount Lofty, South Australia, in June, 1917, have been identified by Lloyd (No. 352). We have also collected specimens at North Bridge, Sydney, in June, 1916, on the ground—pileus 3 cm. broad, gibbous, rugose, slightly upturned, pallid to reddish-brown; flesh dark brown; teeth pallid; stem irregular, more or less central, brownish.

203. *Hydnum alutaceum*, Fr.: Syst. Myc., i., 417; Sacc.: Syll., 6761; Cooke: Handb. Austr. Fungi, No. 934 (Vict.).—Narrabeen, New South Wales (E. C.); Craigie, Victoria, June, 1917, on living bark of *Eucalyptus melliodora*, A. Cunn. (E. J. Semmens, No. 54).

Tremellodon.

204. *Tremelloden gelatinosum*, Scop.: Fr. Hym. Eur., 618; Sacc.: Syll., 6862; Cooke: Handb. Austr. Fungi, No. 942, fig. 68 (Q'land).—Mount Wilson, June, 1915, spores subspherical, 7 to 10·4 μ; National Park, New South Wales, July, 1917, spores 8·5 × 7 μ, 7 μ.

Radulum.

205. *Radulum (Lopharia, Thwaitesiella) Neilgherrense*, Berk. (*R. mirabile* of Ceylon, *R. lirellosa* of Africa, *R. Emerici* of India, and *R. javanica* of Java are considered by Lloyd as probably this species; also *Sistotrema irpicinum*, Berk. and Br., Linn. Trans., ii., 63, t. 13, f. 23, and Cooke, Handb. Austr. Fungi, No. 943 (Q'land), and *Irpex hexagonoides*, Kalchb., Grev. ix., p. 1, and Cooke, Handb. Austr. Fungi, No. 944 (N.S. Wales).—Lloyd has identified specimens for us (Nos. 64, 65, and 113). Milson Island, Hawkesbury River, June and July, 1912; Narrabeen, December, spores pear-shaped, 5 to 6 × 2·5 μ.

Irpex.

206. *Irpex consors*, Berk. Lloyd: Mycol. Notes, 45, 1917, p. 625, fig. 887 (specimens from us). Syn.—Lloyd considers *I. brevis*, Berk.; *I. decurrens*, Berk.; and probably *Hynum meruloides*, Berk., Linn. Trans., ii., 63, t. xiii., f. 4, and Cooke, Handb. Austr. Fungi, No. 926 (Q'land), as all this species. Sydney district, January, April, June, October (spores 5 × 3·4 μ); Narrabeen, April; Hawkesbury River, July (Lloyd, No. 353); Somersby Falls, near Gosford, May; Lisarow, June; National Park, New South Wales, July; Macquarie Pass, August (Lloyd, No. 393); Mount Wilson, June (spores 4 × 2·5 μ; Lloyd, No. 354, who says "the original matches this exactly—largely resupineate with a few pilei"; Victoria, October (C. Brittlebank).

207. *Irpex cingulatum*, Lloyd: Mycol. Notes, 55, 1918, p. 795, fig. 1197.—Lloyd, in describing our specimens (No. 355), says that they differ from *Irpex consors*, which is a white plant, in being washed with a dark zone and appear so different that they should be named. He presumes that the Australian record of *I. zonatus* (Cooke, No. 945, Vict., N.S. Wales, Q'land) is based on this plant, and that the previous

identification by him of a specimen from Australia from J. T. Paul as *I. zonatus* was probably a mistake. New South Wales, spores oval, white, 5·2 × 3·2 μ.

208. *Irpex saepiaria*, Lloyd: Mycol. Notes, 48, 1917, p. 682, fig. 1019.—Lloyd considers that the record of *I. tabacinus* (Cooke, No. 948) for Australia probably refers to this species. Our New South Wales plants (locality not noted) are described by Lloyd as follows in the above Notes:—"Resupinate with reflexed pileus. Pileus coriaceous, dark brown (Brussels), smooth. Context concolorous. Teeth dense, 2 to 3 mm. long, concolorous, irregular. Hymenium white. Setae densely covering the teeth, projecting 20 to 30 μ. Spores globose, 5 μ, smooth." He points out that this species belongs to a section of *Irpex* corresponding to "*Hymenochaete*," and at one time described generically as "*Hydnochaete*."

THELEPHORACEAE.

Thelephora.

209. *Thelephora terrestris*, Ehrenb. Cooke: Handb. Austr. Fungi, No. 981 (Vict.); Clel. and Cheel: Proc. Linn. Soc. N.S. Wales, xli., p. 860 (N.S. Wales, S. Austr.); Syn. *T. laciniata*, Pers. (according to Lloyd); Cooke: No. 982.—Always under or near *Pinus*. Mount Lofty, April, and Adelaide, June, 1917; Ararat, Victoria, June, 1917 (E. J. Semmens); Blayney, December, 1917, when young whitish and encrusting, then frondose. Spores nodular, 7, 8·5, 8·5 × 6 μ.

210. *Thelephora myriomera*, Fr.: Pl. Preiss., 137; Sacc.: Syll., 7129; Cooke: Handb. Austr. Fungi, No. 978 (W. Austr.).—Neutral Bay, Sydney, April, 1915; identified by C. G. Lloyd from the description of this species, no type existing.

Stereum.

211. *Stereum caperatum*, Berk. and M. Cooke: *loc. cit.*, No. 992 (Vict., Q'land); Clel. and Cheel: *loc. cit.*, p. 860.—Lisarow, New South Wales, October, 1916.

212. *Stereum elegans*, Fr. Cooke: *loc. cit.*, No. 994; Clel. and Cheel: *loc. cit.*, p. 861.—Mount Irvine, June, 1915, the upper surface very light brown or damp-looking dark tan; spores 4·2 to 5 × 3·4 μ—identified by C. G. Lloyd; Ararat, Victoria, spores 5 × 3·4 μ (E. J. Semmens, No. 11).

213. *Stereum semilugens*, Kalchb.: Grev., ix., 1; Sacc.: Syll., 7278; Cooke: *loc. cit.*, No. 1010 (Q'land).—Mount Wilson, June, 1915, spores 12 to 14 × 4·2 μ. Lloyd in identifying these adds:—"The surface is relatively smooth and concolorous with the context, ferruginous brown. The hymenium

is cinereous, reminding one of *Polyporus adustus*. Cystidia none. . . . It is a good species, different from anything in Europe or America."

214. *Stereum hirsutum*, Willd. Cooke: Handb. Austr. Fungi, No. 1014; Clel. and Cheel: Proc. Linn. Soc., N.S. Wales, xli., 1916, p. 862.—On *Eucalyptus tereticornis*, Sm., Bumberry, September, 1916; on *E. Stuartiana*, F. v. M., Orange, October, 1916; Taree (H. Lyne), April, 1917; Kew (N.S. Wales), October, 1915; The Rock, July, 1917; Ararat (Vict.), (E. J. Semmens, No. 7).

Lloyd has identified specimens for us as being pale forms approaching *S. vellereum*, Berk. The following belong to this group:—Mount Lofty, on *Eucalyptus* trunks, and National Park, South Australia, June, 1917; Hawkesbury River, February, 1916 (Lloyd No. 373).

215. *Stereum zonarium*, Lloyd: Mycol. Notes, No. 47, 1917, p. 664, fig. 95.—Lloyd has kindly identified New South Wales specimens (locality not noted) for us. His description of these in the above Notes is as follows:—"Pileus sessile to a reduced base, thin, rigid. Surface smooth, reddish-brown (Brussels brown, Ridgway), with narrow, strong, darker zones. Context tissue brown. Hymenial layer white, distinct from the context layer, and often but partially developed over the surface. Basidia clavate, forming a palisade layer. Cystidia none. Spores 3×5 μ, hyaline, smooth." He adds:—"Stereum with smooth pilei are very rare. In fact, we know but one other well authenticated, *viz.*, *Stereum versicolor*, in its true sense."

216. *Stereum vellereum*, Berk.: Fl. N. Zea., 183; Cooke: Handb. Austr. Fungi, No. 1004 (Vict.).—At the base of a trunk, Lisarow, June, 1916, spores 4·2 to $5 \times 3{\cdot}4$ μ. Lloyd in identifying these specimens says that the surface hairs are not so strong as in those specimens he has heretofore referred to this species, but still he believes our specimens belong to it.

217. *Stereum lobatum*, Fr.: Epicr., 547; Cooke: *loc. cit.*, No. 1008 (all the States except S. Austr. and W. Austr.).—Lloyd has kindly identified specimens for us. When moist, zoned with grey and brown or dark browny-chestnut passing to chestnut, yellowish at the periphery; hymenial surface reddish-orange to yellowish-brown and yellow; spores 7 to $7{\cdot}2 \times 3{\cdot}2$ μ. Bulli Pass, April, 1912; National Park, New South Wales, July, 1916; Lisarow, April, June, and December; Mummulgum, near Casino, December; Malanganee, near Casino, August; Barron Falls, Kuranda, Queensland (Mrs. Fraser).

218. *Stereum illudens*, Berk.: Hook. J., iv., 59; Cooke: *loc. cit.*, No. 1015 (all the States); Clel. and Cheel: Proc.

Linn. Soc. N.S. Wales, xli., 1916, p. 863.—Lisarow, June, 1915; National Park, New South Wales, July, 1916.

219. *Stereum membranaceum*, Fr. Clel. and Cheel: *loc. cit.*, p. 863 (N.S. Wales, Q'land).—Kurrajong Heights, August, 1912; Sydney, September; Milson Island, August; Lisarow, June; near Wangan, Pilliga Scrub, October, 1918—dark-brown setae, 50 to 70 × 8·5 μ at the base, acuminate, points acute or blunt.

220. *Stereum (Lloydella) cinerascens*, Schw.—Both of our collections have been identified by Lloyd. Bulli Pass, November, 1917, spores 9 to 10 × 6 to 6·8 μ, metuloids 87 × 25 μ, rough, club-shaped; on dead leaves of *Ficus macrophylla*, Desf., Domain, Sydney, May, 1917.

221. *Stereum (Hymenochaete) adustum*, Lev. (*S. villosum*, Lev.)—"The same, I think, as *Stereum villosum*, Lev., but weathered specimen, the dark colour due to exposure (*S. nigricans*, Lev.; *S. strigosum*, Berk.; *S. phaeum*, Berk.; *S. spadiceum*, Berk., are all synonyms for me)."—Lloyd, in identifying specimens for us found on a fallen log at Lisarow in June, 1916 (brown acuminate setae, 42 × 7 μ). *S. (H.) phaeum* is recorded in Cooke, No. 1034, for Victoria, New South Wales, and Queensland; and *S. (H.) spadiceum* under No. 1037. We have recorded *S. (H.) villosum* for New South Wales (*loc. cit.*, p. 864), and have a further specimen of this from Kurrajong Heights, August, 1912.

Corticium.

222. *Corticium coeruleum*, Pers. Massee: Brit. Fung. Flora, i., p. 127.—Dorrigo, January, 1918, identified by Lloyd (No. 475).

GASTEROMYCETES.

Chlamydopus.

223. *Chlamydopus Meyenianus*, Berk. Lloyd: Lycop. of Austr., 1905, p. 9, fig. 6; Clel. and Cheel: Jour. Proc. Roy. Soc. N.S. Wales, l., 1916, p. 109; as *Tylostoma maxima*, Cke. and Mass. in Cooke, Handb. Austr. Fungi, No. 1237, fig. 113 (W. Austr.).—We have received specimens of this rare species from Mrs. A. F. Cleland from Kurrawang, near Kalgoorlie, July, 1918. The peridium is ¾ inch broad and ⅜ inch high, flattened spherical in shape, the apex irregularly torn with an aperture about ⅓ inch × ¼ inch; stem 3 inches high, ¼ inch thick above, slightly attenuated downwards, striate, pallid; volva as a definite cup, ½ inch high, widely separated from the stem above; gleba light rusty in colour; spores finely rough, 6·8 μ.

Battarea.

224. *Battarea phalloides*, var. *Stevenii*; Lloyd: *loc. cit.*, p. 11, pl. 28, figs. 2 and 3; Clel. and Cheel: *loc. cit.*, p. 111: Cooke: Handb. Austr. Fungi, No. 1243 (W. Austr.), and as *B. Muelleri*, No. 1244 (S. Austr.), and *B. Tepperiana*, No. 1245 (Vict.).—Baan Baa, New South Wales, stem up to 12 inches high, attenuated upwards, very shaggy; volva buried in the ground.

Geaster.

225. *Geaster Clelandii*, Lloyd: Mycol. Notes, No. 55, 1918, p. 794, fig. 1196.—The type and cotype were found by Mrs. A. F. Cleland at Kalgoorlie in June, 1917. Lloyd describes the species as follows:—"Exoperidium rigid, incurved when dry, cut into eight (in this specimen, also in the cotype) rather narrow lobes. Endoperidium scurfy, with a short, thick pedicel. Mouth protruding, strongly furrowed." He adds:—"The single specimen of this plant presents a character to separate it from others of the section (Rigida, Cfr. Myc. Notes, p. 317) to which it belongs. It has a pedicellate endoperidium. The colour is decidedly reddish, but it grew in red soil, which no doubt has something to do with the colour. Geasters are best defined in terms of others. This is *Geaster Schmidelii* as to size, pedicel, and mouth, but the exoperidium puts it in a different section. It is *Geaster striatulus* excepting the endoperidium, which is pedicellate. As a matter of fact, it is probably the original of *Geaster striatulus*, which was from Australia and not authentically known (Cfr. Myc. Notes, p. 312), and which was described as endoperidium 'subsessile.' But it is entirely different from *Geaster striatulus* in the sense of Hollós, which we have adopted and illustrated several times (Cfr. Myc. Notes, p. 71, and Lycop. Austr., p. 16)."

226. *Geaster floriformis*, Vitt. Lloyd: Lycop. of Austr., 1905, p. 16, fig. 10; Cooke: Handb. Austr. Fungi, No. 1264 (Vict., Q'land); Clel. and Cheel: Journ. Proc. Roy. Soc. N.S. Wales xlix., 1915, p. 221.—Manildra, New South Wales, October, 1916, identified by C. G. Lloyd—spores finely rough, 3·4 to 4 μ.

227. *Geaster simulans*, Lloyd: Lycop. of Austr., 1905, p. 17, fig. 11; Clel. and Cheel: *loc. cit.*, p. 220; as *G. hygrometricus*, Pers., in Cooke, Handb. Austr. Fungi, No. 1268 (W. Austr., Q'land).—Manildra, October, 1916, identified by Lloyd—spores nearly smooth, 5·2 μ; Dubbo, October, 1915—spores rough, 5·8 μ; Mount Lofty, South Australia, July, 1914—spores rough, 4 to 6 μ.

228. *Geaster Berkeleyi*, Lloyd: Lycop. of Austr., p. 19.—Mummulgum, near Casino, December, 1916, spores rough, 3·5 μ.

229. *Geaster minimus*, Schwein. Lloyd: Lycop. of Austr., p. 21—Narrabri, November, 1916, spores finely rough, 3·5 to 4·5 μ; Baan Baa, January, 1917, spores rough, 5 μ—both kindly identified for us by C. G. Lloyd.

230. *Geaster saccatus*, Fr. Lloyd: Lycop. of Austr., p. 22; Clel. and Cheel: Jour. Proc. Roy. Soc. N.S. Wales, xlix., 1915, p. 225.—Bumberry and Manildra, September and October, 1916, identified by Lloyd, who says "larger than our (*i.e.*, the American) plant and tending towards *rufescens*"—spores distinctly rough, 5·8 to 6·8 μ; Manildra, October, 1916, identified by Lloyd as a small form—spores finely rough, 3·5 μ; Forbes, August, 1915, spores smooth, 3 μ; Murwillumbah, April, 1916, spores rough, 3·8 to 5 μ.

Mycenastrum.

231. *Mycenastrum corium*, (Guersent) Desv. Clel. and Cheel: Jour. Proc. Roy. Soc., N.S. Wales, l., 1916, p. 116.—Dungog, New South Wales, November, 1916, spores 10·5 μ; Beaumont, near Adelaide, June, 1917, spores shaggy, 8·5 to 9 μ; Kalgoorlie, June, 1917, spores rough, 10·4 to 12 μ.

Lycoperdon.

232. *Lycoperdon gemmatum*, Batsch. Clel. and Cheel: Jour. Proc. Roy. Soc. N.S. Wales, l., 1916, p. 122, No. 30.—National Park, New South Wales, on and near rotten wood, July, 1916, spores finely rough, 3·6 to 4 μ; New South Wales, spores spherical, very finely warted under oil-immersion lens, 3·5 to 4 μ.

Calvatia.

233. *Calvatia lilacina*, (Berk.). Clel. and Cheel: *loc. cit.*, p. 123, No. 32.—Baan Baa, January, 1917, identification confirmed by Lloyd (Nos. 287 and 288), spores echinulate, 5 μ, capillitium branching, 3·5 μ in diameter—in one of these specimens the substance is bleached to a pale fawny-whitish colour; Sydney, May, 1918; Krambach, near Taree, January, 1918, spores echinulate, 5·5 μ; Craigie, Ararat, May, 1918 (E. J. Semmens, No. 90).

ASCOMYCETALES.

Fam. TUBERACEAE.

Endogone.

234. *Endogone tuberculosa*, Lloyd: Mycol. Notes, No. 56, October, 1918, p. 799.—The type specimens were obtained

by one of us (J. B. C.) at The Rock, New South Wales, in July, 1917. Mr. Lloyd's description of the species is as follows:—"1-2 cm. thick, globose, pale orange. Surface tuberculate. Peridium indistinct. Gleba convolute, lacunose, yellow. Vesicle imbedded in the context tissue, globose, 50-60 mic., with thick, hyaline walls and granular, yellow contents." Lloyd adds that, possessing the characteristic vesicles of the genus *Endogone*, this is best so referred, but it differs from all other species in the lacunose gleba and tubercular surface. Our notes state that the plants were just above the ground, ½ inch in diameter when fresh, pallid orange in colour, and with a tuberculate surface. The vesicles were large, oval, thick-walled bodies, 85 × 60 μ in size in some cases, with granular contents.

DISCOMYCETIINEAE.

Fam. HELVELLIINEAE.

MORCHELLA.

235. *Morchella esculenta*, L. Pers.: Syn., 618; Sacc.: Syll., viii., 8; Cooke: Handb. Austr. Fungi, No. 1353 (no locality).—Victoria, September, 1913 (asci cylindrical, occasionally slightly wavy, 243 × 17·4 μ, spores oval, 19 to 20·7 × 11·2 μ).

236. *Morchella conica*, Pers. Cooke: Myco., t. 81, f. 315; Sacc.: Syll., viii., 10; Cooke: Handb. Austr. Fungi, No. 1354, f. 139 (Vict., S. Austr., Tas.); Cambage: Proc. Linn. Soc., N.S. Wales, 1901, p. 691 (N.S. Wales); Clel. and Cheel: Jour. Proc. Roy. Soc. N.S. Wales, xlviii., 1914, p. 443 (N.S. Wales).—Victoria, September, 1913 (asci 210 × 21 μ; spores 24 to 26 × 16 μ).

LEOTIA.

237. *Leotia marcida*, Pers. Lloyd: Geoglossaceae, p. 15.—Specimens have been identified for us by Llyod (No. 161), who says that many authors consider this species as merely a colour form of *L. lubrica*, Pers. Our collecting notes are as follows:—Pileus ¾ inch wide and ½ inch high, irregularly nodular or "bumpy," greenish-waxy looking, the undersurface slightly concave and paler and more watery in appearance, on section tremelloid and watery waxy-looking. Stem 1¼ inch high, ¼ inch thick, yellow-waxy looking, punctate with slightly darker, apparently warty, particles, on section showing an outer clear cortex and a thick solid yellow-waxy core, which expands in the pileus as a thin disc. The spore-bearing part of the ascus about 60 × 10·5 μ, the whole ascus about 140 μ long. Spores overlapping in the ascus, 17·5 to

21 × 6 μ, ends rather pointed, usually with four large globules. Under trees, Lane Cove River, Sydney, June, 1916; Dr. Darnell Smith also collected specimens in the same month and year at Somersby Falls, Gosford; Neutral Bay, May, 1917; Mosman, April and May, 1918 (asci 60 to 70 μ, spores 17·5 × 4·2 μ, one side of the spore a little flattened).

Geoglossum.

238. *Geoglossum Muelleri*, Cooke: Myco., t. 1, f. 2; Sacc.: Syll., 138; Cooke: Handb. Austr. Fungi, No. 1362 (Vict.).—1¾ inch high. Club slightly viscid when moist, a little shorter than the stem, black. Stem shining. Asci fusiform. Sporidia 3-septate, 58 to 66 × 5 μ. Under bushes, Parramatta, July, 1912.

239. *Geoglossum glabrum*, Pers.: Syn., p. 608; Sacc.: Syll., 141; Cooke: Handb. Austr. Fungi, No. 1363 (Vict., Q'land).—Club ½ inch high, ¼ inch wide, flattened, slightly sulcate, matt, almost black. Stem 1¼ inch high, attenuated downwards, dark chocolate, and lighter than the club. Asci 139 to 174 × 18 μ. Sporidia brown, 7-septate, 56 × 6 μ. On the ground, Neutral Bay, June, 1913 (identified by Lloyd, No. 230). We also have the following:—New South Wales, asci cylindrical club-shaped, 120 to 138 × 13·8 μ. sporidia brown, 7-septate (one 6-septate), 72·5 × 4·8 μ. Sedgwick, Victoria (E. J. Semmens), amongst mosses, asci 155 × 17 μ, sporidia brown, 7-septate, 53 to 61 × 7 μ.

Fam. PEZIZACEAE.

Phillipsia.

240. *Phillipsia polyporoides*, Berk.: Linn. J., xviii., 386; Sacc.: Syll., 608; Cooke: Handb. Austr. Fungi, No. 1399 (Q'land); Lloyd: Letter 62. Note 432, 1916.—Specimens obtained at Kurrajong Heights on a fallen log in August, 1912, are considered by Lloyd, from Berkeley's description, to be probably this species, though he sees no justification for the specific name. He adds that the genus *Phillipsia* is close to *Urnula*, though put in a different section in Saccardo. He describes our specimens as being thick, dark, coriaceous, and cup-shaped, with large, hyaline, arcuate, smooth spores, 12 × 36 μ, and numerous dark, filiform paraphyses, slightly enlarged at the apices. Our measurements show slightly curved spores. 27 to 29·5 × 10·14 to 12 μ. We have also specimens collected by Prof. S. J. Johnston at Kendall in June, 1917, on wood—asci cylindrical, 313 to 340 × 12 to 14 μ, spores white, slightly curved, 25 to 28 × 10·5 μ.

Urnula.

241. *Urnula campylospora*, (Berk.) Cooke; *Peziza campylospora*, Berk.: Fl. N. Zeal., 200; *Geopyxis cinereo-nigra*, B. and Br.; *Peziza cinereo-nigra*, B. and Br.: Linn. Trans., i., 404, t. 46, f. 16-18; Lloyd also mentions as synonyms *Rhizina reticulata* and *Peziza rhytidia*, and quotes Massee for a figure (Jour. Linn. Soc., xxxi., pl. 16, f. 17); as *Urnula campylospora* in Cooke, Handb. Austr. Fungi, No. 1453, f. 165 (Q'land), and in Lloyd, Mycol. Notes, No. 49, 1917, p. 695, f. 1037.—Lloyd has identified two collections for us. On wood, Lisarow, August, 1916 (asci 350 × 17 μ, sporidia curved 26 × 8·5 μ). On fallen wood, National Park, New South Wales, July, 1916 (under-surface and stalk black, finely rough; cup dark brown, then blackish; sporidia curved, sausage-shaped, 27·5 to 31 × 10·4 to 12 μ).

PYRENOMYCETIINEAE.

Fam. HYPOCREACEAE.

Hypomyces.

242. *Hypomyces aurantius*, Tul.: Carp., iii., 43; Plow.: Grev., iii., 44, t. 150; Cooke: Handb. Austr. Fungi, No. 1508 (Q'land).—Lloyd has identified a specimen for us, found on old *Polyporus Berkeleyi* at Lisarow in June, 1916. He thinks this is probably also *H. rosellus* (Cooke, No. 1506, W. Austr.). Asci about 100 × 5 μ; sporidia constricted in the centre, pointed at the ends, 17·5 × 3·4 μ (Lloyd found them to be 20 to 24 × 5 to 6 μ, hyaline, smooth, septate).

Fam. XYLARIACEAE.

Xylaria.

243. *Xylaria anisopleura*, Mont.: Syll., 688; Cooke: Handb. Austr. Fungi, No. 1535 (Q'land); as *X. tuberiformis*, Berk., in Lloyd, Mcyol. Notes, No. 48, 1917, p. 678, fig. 1011 only, later in Xylaria Notes, ii., 1918, p. 24, on the advice of Petch referred to *X. anisopleura*.—Our specimens, identified by Lloyd (No. 228), and referred to and figured in the above Notes, were gathered on a fallen trunk at Mount Irvine in June, 1915—asci about 100 μ long; spores black, often slightly curved, 12·5 × 7 μ.

244. *Xylaria phosphorea*, Berk. (?): Linn. J., xiii., 177; Grev.: xi., t. 168, f. 75; Cooke: Handb. Austr. Fungi, No. 1537 (Vict.).—Specimens collected by Dr. Darnell Smith at Mount Irvine in January, 1915, were identified by Lloyd (No. 229), with much doubt, as this species—asci about 104 × 8·5 μ; spores black, 12 to 13·8 × 6·6 μ, one side slightly flattened.

245. *Xylaria myosurus*, Mont. (?)—Lloyd has identified specimens (No. 269), collected on a rotten trunk at Katoomba in December, 1916, as probably immature examples of this species. Conidiospores 7 to 10·4 × 3·5 to 4 μ, dagger-shaped.

246. *Xylaria faveolis*.—Lloyd, Xylaria Notes, i., 1918, p. 9, figs. 1214-1216.—Lloyd has identified specimens for us (No. 440), referred to and figured in the above Notes. The plants were collected at Dorrigo in January, 1918—asci about 70 × 6 μ, spores 10·4 × 4 μ, blackish, one side a little flattened.

247. *Xylaria hypoxylon*, Grev.: Fl. Edin., 355; Sacc.: Syll., 1260; Cooke: Handb. Austr. Fungi, No. 1547 (Q'land).—Lloyd has identified as probably the conidial form of this species specimens (No. 268) found at the base of a dead tree-fern at Katoomba in December, 1916—conidiospores 8·5 × 2 μ, elongated, one end more pointed.

Sarcoxylon.

248. *Sarcoxylon Le Rati* (Hennings). Lloyd: Mycol. Notes, 1917, No. 47, p. 668, fig. 960; *Xylaria gigas* (?), Cooke: Handb. Austr. Fungi, No. 1539 (N.S. Wales), is thought by Lloyd to be possibly this species.—Lloyd places this genus close to *Xylaria*. He has identified for us as *Sarcoxylon Le Rati* the specimens mentioned in his Mycological Notes. The species was previously, he states, only known from New Caledonia. Our specimens were found on the ground under trees at Lisarow, New South Wales, in December, 1916. The plants when fresh were in shape somewhat like large examples of one of the forms of *Polysaccum pisocarpium*, *i.e.*, broadly club-shaped. They were attached to large irregular white mycelial masses in the ground. The surface was covered with a yellow efflorescence showing numerous conidial spores (8·5 to 12·5 × 2 to 3·4 μ). On section the centre was whitish and surrounded by a broad yellowish layer, whilst outside this was a black line covered with the yellow efflorescence. Smell unpleasant.

Poronia.

249. *Poronia punctata*, L. Cooke: Handb. Austr. Fungi, No. 1548 (Vict., Tas., W. Austr.).—Specimens collected on dung at Orange in October, 1916, were identified by Lloyd (No. 227)—asci 156 μ long, spores black, 26 to 27 × 15·5 μ.

250. *Poronia oedipus*, Mont.: Ann. Sci. Nat., 1855; Cooke: Handb. Austr. Fungi, No. 1549 (Vict., N.S. Wales, Q'land).—We have two New South Wales collections, both identified by Lloyd (Nos. 225 and 226)—asci 121 × 17 μ, spores oval, surrounded by mucus, 19 × 8·5 μ (immature).

Nummularia.

251. *Nummularia Baileyi*, B. and Br. Cooke: Hand. Austr. Fungi, No. 1554 (Q'land).—New South Wales specimens have been identified for us as probably this species by Lloyd (No. 223)—spores blackish, 17 × 8·5 to 12 μ, ends sometimes pointed.

Daldinia.

252. *Daldinia concentrica*, Bolt. Cooke: Hand. Austr. Fungi, No. 1561, fig. 202 (all the States except S. Austr.).—Mosman, Sydney, New South Wales (spores slightly curved, 13·8 to 15·5 × 7 μ, asci 8·5 μ in diameter); Malanganee, New South Wales, August (spores oval, 10·4 to 13·8 × 6 to 8·5 μ); Kendall, August; Flinders Island, Bass Straits, November (spores black, obliquely elongated, slightly pointed, 13·8 to 15·5 × 7 to 7·2 μ). See also Proc. Linn. Soc. N.S. Wales, xxxvii., p. 236 (1912), for previous record.

DESCRIPTION OF PLATES.

Plate XXVIII.

Amanitopsis punctata, n. sp., with section, volva, and spores.

Plate XXIX.

Fig. 1. *Cantharellus lilacinus*, n. sp., with spore.
,, 2. ,, *corrugatus*, n. sp., with spore.
,, 3. *Mycena banksiae*, n. sp., with spore.
,, 4. ,, *coccineus*, n. sp., with spore.
,, 5. *Boletus scarlatinus*, n. sp.
,, 6. ,, ,, ,, small form with spore.

The Petrology of the Granitic Mass of Cape Willoughby, Kangaroo Island:—Part I.

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(Communicated by Professor Walter Howchin.)

[Read September 11, 1919.]

Plates XXX. and XXXI. and 2 Maps.

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I. Introduction.
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V. The Nature and Composition of the White Pegmatite.
VI. The Relations of the Rock Types.
VII. General Discussion.

I. Introduction.

The imposing granite headland of Cape Willoughby forms the easternmost extremity of Kangaroo Island. From the standpoint of petrology this locality has received little attention, and in the previous literature dealing with this area brief reference only is made to the intrusion. This literature is:—

(i.) Howchin, W.: Trans. Roy. Soc. S. Austr., vol. xxvii., 1903, pp. 80-83.

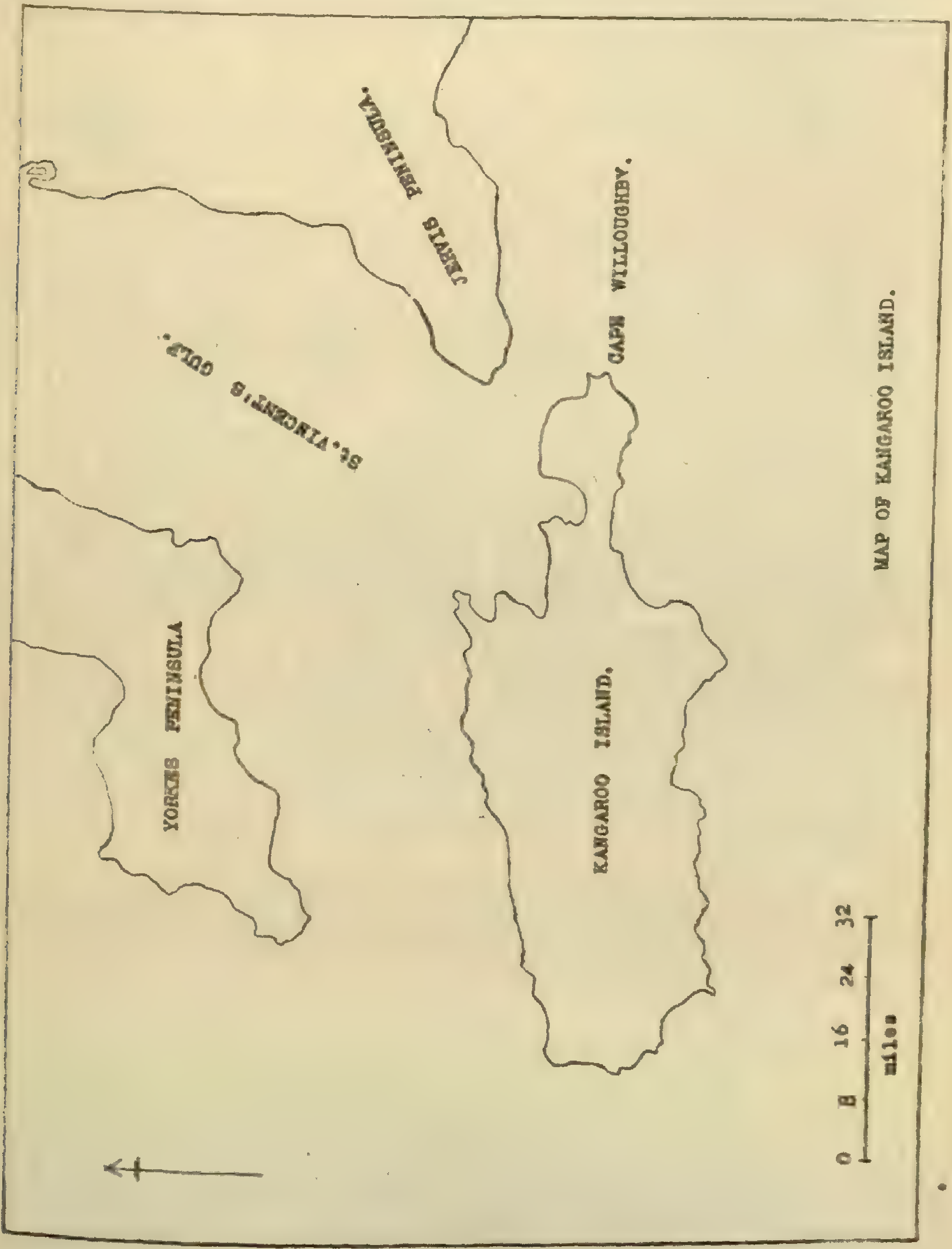
(ii.) Wade, A.: Bull. No. 4, Geol. Surv. S. Austr., pp. 20 and 21.

In addition the writer has described certain quartz tourmaline nodules from this area.(1)

Howchin, while investigating the geographical extent of the late Palaeozoic (Permo-carboniferous) glacial deposits on Kangaroo Island visited Cape Willoughby, and in his subsequent paper briefly refers to the granite and its minor intrusions. Wade mentions its intrusive character into the

(1) Tilley: Trans. Roy. Soc. S. Austr., 1919, p. 156.

associated quartzites, and both investigators note the remarkable blue opalescence of the quartz grains present in the granite.



As far as the writer is aware, no further data are available of this intrusion.

II. General Description.

The granite mass occupies an area of approximately 2 square miles, and forms a length of coastline of $5\frac{1}{4}$ miles. In plan the outcrop is roughly triangular, in shape approaching a right-angled triangle, with the coastline forming the two sides of the right angle.

Along the sea coast, the granite ends sharply up against dark-coloured quartzites, which macroscopically suffer little or no change; nor does there appear to be a border or contact zone to the granite, for this retains the mineralogical and textural characteristics of the main mass.

The intrusive nature of the mass is well shown by the manner in which the granite cuts across the strike of the quartzites and by the presence of rifted blocks of the quartzite (accidental xenoliths), which are developed near the contact and are obviously derived from the country rock.

At the northern sea coast contact with the country rock, small aplitic veins proceed into the micaceous quartzites, which are here striking north-east with a south-easterly dip at 64°. The rifted blocks maintain proximity to the contact surface. At the southern sea coast termination of the granite xenoliths are less numerous and are generally small. The quartzites here have the same north-east and south-west strike, but dip south-east at 74° to 80°.

In the granite, near the junction, occur quartz geodes lined and filled with tourmaline. Associated with the granite occur a series of aplitic and pegmatitic dykes, which are clearly younger than the main mass of granite, for they are seen to cut across and intersect it. These intrusions bear a close relationship to the granite, and form a highly interesting series.

The main occurrences are listed below:—

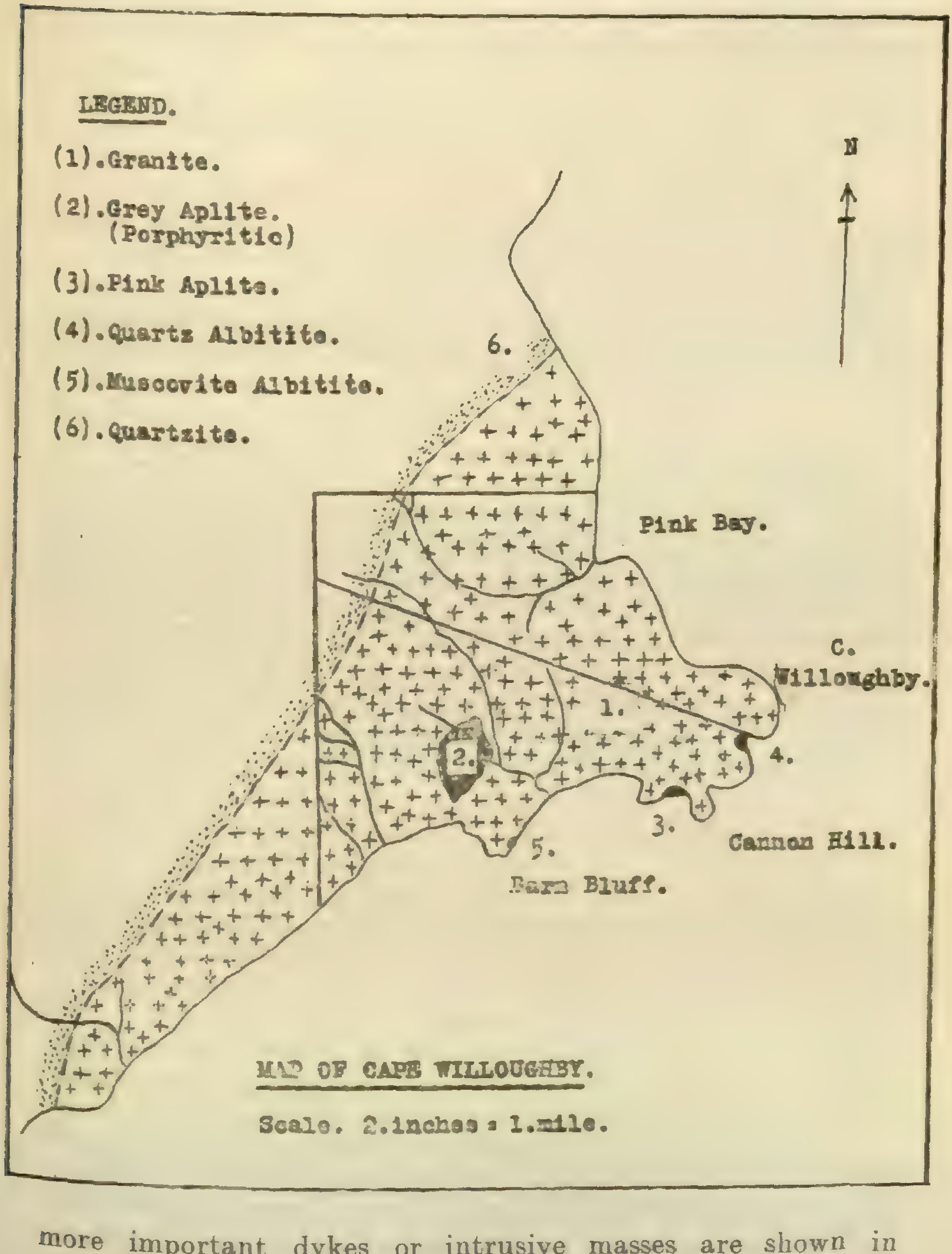
(i.) A large elliptical (in cross section) mass of grey aplite is developed behind Barn Bluff.

(ii.) A smaller mass occurs on the sea coast, south of Cannon Hill. This is a pink aplite.

(iii.) Minor dykes of a white pegmatite occur at the northern side of Barn Bluff at the head of the first gully south of the lighthouse, and veins both north and south of Pink Bay. These latter veins have the trend for the most part of the joint planes of the granite.

In the main mass of granite segregations are sporadically distributed. These are generally ovoid and finer-textured patches (cognate xenoliths). Some show a slightly darker colour than the general colour of the normal granite.

In the accompanying map, the extent of the granite mass is outlined, and its contact with the quartzite-schist country rock shown. The inland junction is only approximate. The



MAP OF CAPE WILLOUGHBY.

Scale. 2.inches = 1.mile.

more important dykes or intrusive masses are shown in addition.

No detailed petrographic study has been made of the country rocks, which consist of quartzites, quartz-mica

schists, and mica schists. The whole region has suffered considerable regional metamorphism, in common with the metamorphism shown by the eastern beds of the Mount Lofty Ranges on the mainland. The differentiation of contact and regional metamorphism for the area under consideration would demand much careful field and petrographic study.

III. Characters of the Rock Types.

(a) THE MAIN GRANITE.

Throughout the mass, the granite maintains a very constant mineralogical and textural character. In hand specimens the rock is more or less even-grained, with the occasional development of phenocrysts of unstriated felspar. The most striking feature of the rock is the presence of subidiomorphic crystals of quartz, showing a remarkable blue opalescence. This quartz is also developed in the minor intrusions associated with the granite. The felspar shows well-developed cleavages, and often contains inclusions of biotite. Occasionally a felspar phenocryst may show, with the aid of a lens, an intergrowth with quartz—suggestive of a graphic intergrowth. According to the freshness of the rock the felspars are seen as greyish, pink, or tending to greenish in colour. The dark mineral is biotite. In addition small quantities of iron pyrites can be detected in some specimens. Under the microscope the minerals developed are seen to be quartz, microcline, plagioclase, biotite, and, as accessories, muscovite, apatite, ilmenite, pyrites, and zircon. As secondary minerals there are present epidote, leucoxene, sericite, kaolin, and chlorite.

Quartz occurs, firstly, as subidiomorphic grains with well-developed cracks, and showing undulose extinction. These represent the grains seen in hand specimens. Minute inclusions are very numerous, and in many cases appear to be laid out in strings. Many of these undoubtedly are fluid or gaseous inclusions, whilst others appear to be solid, and probably represent rutile needles. Whilst in reflected light this quartz is characterized by a bluish opalescence, in transmitted light it has a distinct yellowish to reddish yellow appearance, according to the thickness viewed.

Again, some of the quartzes when carefully examined show zones of alternate clear and opalescent layers in reflected light, and, in transmitted light, these show up as colourless and yellowish areas respectively. These zones appear to follow the outlines of the growing crystal. $D^{20^\circ}_{4^\circ} = 2{\cdot}650$. It is not proposed to consider this question in the present paper, as the subject is reserved for a subsequent communication.

In some sections it would appear that, as an accompaniment of cracking, there has been a rotation of sectors of the grain, for the grain is not optically continuous throughout. Along these cracks the quartz may show higher polarization colours.

Quartz is also present in the slides in allotrimorphic grains, or as a constituent of a graphic intergrowth with microcline. This intergrowth may develop around the large quartz or microcline crystals, and is obviously of later crystallization.

Microcline is present in subidiomorphic crystals, which may show inclusions of biotite, plagioclase, and quartz. The microcline twinning after the albite and pericline laws is very finely developed, and the lamellae are often seen to overlap. In sections parallel to (010) pericline twinning may be absent or submicroscopically developed; where clearly developed, however, it cuts the trace of the (001) cleavage at an angle of 74°-76°.

Extinction on (010) sections has a maximum value of 6°-7° from the basal cleavage. Some sections show a very fine perthitic intergrowth with plagioclase. The layers traverse the microcline, and are optically continuous; optically they have the properties of albite. This is the typical microcline microperthite structure.

Plagioclase occurs in more or less tabular crystals of well-developed form, and shows the characteristic albite lamellae. Zoning is characteristic. The refractive index is $>$ C. Balsam, and most sections show R.I. $<$ quartz.

In zoned sections showing no multiple twinning the extinction from the (001) cleavage read as maxima:—

Outer zone	+9°
Intermediate zone	10°
Central zone	−9°

This corresponds to a range from Oligoclase (Ab_4 An_1) to Andesine (Ab_3 An_2).

Such zoned sections (010) in convergent light show the emergence of a bisectrix to be practically normal to the section. This is the obtuse bisectrix, and the negative birefringence is clear.

The felspar is an Oligoclase-Andesine, the average composition being nearer the oligoclase end.

Some sections of the granite show the presence of a more acid plagioclase than the above. This has the properties of oligoclase albite. It represents a later stage of crystallization, but is of minor development.

Biotite.—This mineral is developed in clusters of flakes of elongated section showing the strong basal cleavage. The

colour is dark brown to greenish-yellow. The pleochroism is intense, showing practically complete absorption. The biotite encloses such minerals of earlier formation as apatite, zircon, and ilmenite.

Chlorite and epidote are developed as secondary products. The small amount of muscovite occurs in association with the biotite, and is of later crystallization. It remains clear and unaltered.

Apatite occurs in slender needles and small hexagonal prisms. It is most abundant as inclusions in the biotite.

Ilmenite is associated with the biotite, and is generally surrounded by a white leucoxenic decomposition product.

Zircon, like apatite, is enclosed in biotite, and occurs in short prisms. It is usually surrounded by faint pleochroic haloes.

Epidote is present, associated with biotite and plagioclase; it probably results from the interaction of biotite and plagioclase, and is obviously of secondary origin. Calcite may be developed in addition.

Kaolin occurs as a dust accompanying both felspars.

The cores of some sections of the plagioclase show plentiful sericite, occurring in small flakes, sometimes to the complete exclusion of the felspar, from which it has developed. It is probably paragonitic in composition.

The order of crystallization of the constituent minerals may be subdivided as:—

I. Accessories—Apatite, ilmenite, zircon.
II. Biotite and accessory muscovite.
III. Plagioclase—Quartz and microcline.

Overlapping of the crystallization periods of II. and III. occurred, as is evidenced by inclusions. This particularly refers to microcline, which in its occasional porphyritic development is then referable to an early stage. The order of cessation of crystallization is more truly represented by the above arrangement.

Nearing the completion of crystallization, the sodic character of the plagioclase had become marked, in some sections oligoclase-albite being developed independently, and the last stages are represented by the graphic intergrowths of quartz and microcline which surround the larger crystals.

The relative proportions of plagioclase to microcline felspar show some variation in the different sections examined. As a whole they are present in approximately equal amounts. The granite may therefore be placed in the Adamellite group.

Cognate Xenoliths.—These occur as ellipsoidal or ovoid patches in the main granite. In hand specimens they appear

as moderately dark-greyish, fine-grained aggregates, with the occasional development as phenocrysts of the characteristic blue opalescent quartz seen in the main granite. Microscopically the segregations are seen to consist of the minerals of the main granite. Biotite is present in ragged flakes and, in parts, is altered to chlorite; epidote is also present as a secondary product. In some cases the remains of biotite are now only represented by chlorite and epidote together.

Ilmenite is sparingly present with its leucoxenic decomposition product.

Phenocrysts of quartz and oligoclase-andesine or andesine are present, and the remaining mass consists of a fine-grained assemblage of allotrimorphic quartz and microcline, mostly untwinned.(2)

The microcline is heavily dusted with kaolin. With the plagioclase the secondary development of scaly mica appears more usual. There is a minor amount of graphic intergrowth of quartz and felspar (microcline).

The specific gravity of one of these ovoid segregations was determined as 2·655 (16° C). The specific gravity of the main granite is 2·668 (16° C). $D^{16°}_{4°} = 2·668$.

The segregations show a variable amount of biotite, the one in question being, if anything, freer from this mineral than the average. In some cases their slightly darker colour, as an indication necessarily of a greater concentration of biotite than in the main granite, is probably illusory, in that they are finer grained, and the biotite is more evenly distributed than in the main granite.

(b) THE MINOR INTRUSIONS.

For the purpose of later discussion these minor intrusions can be separated into three distinct groups:—*(a)* The grey aplite; *(b)* the pink aplite; *(c)* the white pegmatite. These will be treated *seriatim.*

(a) The Grey Aplite.—This occurs as an intrusive mass, elliptical in plan, behind Barn Bluff *(vide* map). In hand specimens it is a fine-grained light-grey rock with development

(2) The absence of microcline twinning in some sections of the potassic felspar is not considered sufficient evidence to interpret the rock as possessing orthoclase in addition. The presence of microcline is definitely fixed by its characteristic "grating" structure, but it is quite possible for microcline to occur with albite twinning alone or no twinning at all. The very general presence of microcline in the older plutonic rocks is suggestive that this mineral is really the stable phase of potassic felspar. On this question *cf.* C. H. Warren, "A Quantitative Study of certain Perthitic Felspars" (Proc. Amer. Acad. Arts and Sciences, vol. 51, No. 3, 1915, pp. 127-154).

of occasional phenocrysts of the characteristic opalescent quartz, bunches of biotite, and very sparingly an occasional phenocryst of felspar. A few scattered grains of pyrites are also present.

The specific gravity of this rock is 2·625. $D^{18°}_{4°} = 2·625$.

Under the microscope the quartz phenocrysts have the same characteristics as possessed in the normal granite.

Biotite is spread sporadically through the rock with its accompanying chlorite and epidote. Pyrites is also present.

Quartz and microcline are developed, showing allotrimorphic boundaries. The microcline shows Carlsbad twinning, but the grating structure may be absent or represented only by submicroscopic lines of light and shade.

Some plagioclase is present, and has the properties of oligoclase albite.

Secondary mica and kaolin are developed as alterations of the felspar. In a phenocryst of microcline the micasation may be well developed.

A primary micrographic intergrowth of quartz and microcline is often present round the borders of a large quartz grain. A determination of alkalies in this rock gave $K_2O = 5·58\%$, $Na_2O = 2·63\%$.

The rock is a Biotite Microcline Aplite. In parts it has a distinct granite-porphyry facies, but its relationship to the associated intrusions is better indicated in the name given.

(b) The Pink Aplite.—This aplite occurs as a distinctly intrusive mass along the coast immediately south of Cannon Hill. Its junction with the granite is in most places markedly sharp. The mass shows a somewhat variable texture throughout its extent: the greater part is of very fine grain, but this grades into a coarser variety, in which are developed phenocrysts of blue quartz and a ferromagnesian mineral, biotite, also makes its appearance. It is an aplite with development in part of a distinct granite-porphyry facies.

It is in this rock that occur the quartz tourmaline nodules already described in detail in a previous paper.[(3)]

A number of quartz veins occupy fissures in the aplite, and associated with these veins occurs a zone of altered aplite which appears to be of the nature of a greisen.

A further alteration of the aplite is the production along fissures of a white kaolinized product. A number of quartz geodes are also developed. Microscopic description of this aplite is dealt with on page 325.

(c) The White Pegmatite (Aplite).—There are a number of occurrences of this type all of which are not noted on the

(3) Tilley: *loc. cit.*

map. Some occur as veins in the main granite. The first occurrence noted is in the first gully south of the Cape Willoughby Lighthouse. The dyke outcrops at the head of the gully, and has a width of eight yards. Its boundaries are ill-defined and are covered with sand. In hand specimens it is a coarse aggregate of blue quartz and white felspar, apparently not graphically intergrown.

A second pegmatite with predominant felspar and showing strings of quartz is well developed on the northern side of Barn Bluff. Limonite is associated with the felspar in parts as a subsequent alteration; muscovite is also present. The rock has weathered out into honeycombed masses.

The remaining occurrences of this rock are in the form of veins, which outcrop on both sides of Pink Bay, along the coast. They vary in width from 2 ft. downwards, and vary in composition from an aggregate of blue quartz and white felspar to veins of pure felspar. For the most part these veins run parallel to the trend of the joint planes in the granite.

The three types of minor intrusion occur as separate and distinct masses. In no case have they been observed in association, to enable their order of intrusion to be determined. These, too, were the only types of intrusions seen exposed in the granite mass.

Minor intrusions into the neighbouring quartzites were not observed; about seven miles from Cape Willoughby a pegmatite dyke is developed in schist. Gem tourmaline has been derived from this area, and the dyke is most probably an offshoot from the Willoughby mass. The writer had not an opportunity of visiting this locality.

Microscopically, the minerals present in the pink aplite are quartz, microcline, plagioclase (albite), and, as accessories, biotite (much chloritized), and muscovite. Kaolin and secondary mica accompany the felspars as alteration products.

One slide shows a well-developed phenocryst of plagioclase as a trilling, and, in addition, albite lamellae are present. This is probably an oligoclase albite. It is surrounded by a beautiful micrographic intergrowth of quartz and microcline.

The micrographic intergrowths are displayed more especially in the coarser varieties of the intrusion. In these, also, apatite begins to appear and muscovite is more plentifully distributed, often in plumose fashion. Some of the albite shows twinning after both albite and pericline laws. In the finer-grained types the fabric approaches the type "granulitic" characteristic of some aplites.

In an aplite near Pink Bay, related to this series, subidiomorphic grains of magnetite appear, and in addition

there are present a few scattered grains of blue strongly pleochroic tourmaline. The albite in this rock is more abundant than in the aplite described above.

The specific gravities of the rocks of this series are indicated below:—

(i.) Fine-grained red aplite, $D^{18°}_{4°} = 2.590$.

(ii.) Medium-grained red aplite, $D^{20°}_{4°} = 2.602$.

(iii.) Coarse-grained red aplite, $D^{15°}_{4°} = 2.605$.

(iv.) Aplite from near Pink Bay, $D^{15°}_{4°} = 2.625$.

The aplites of this series are characterized by the predominance of microcline felspar; plagioclase is subordinate. This plagioclase is an acid albite, and in the finer-grained aplite may appear as idiomorphic phenocrysts rarely, the main development being in association with the quartz and mircrocline. The listed specific gravities further point to the dominant felspar being potassic. A partial analysis of the fine-grained red aplite yielded $K_2O = 5.48\%$, $Na_2O = 2.79\%$.

The pink colour of this series is due to the presence of a fine film of haematite dusting the cleavages and cracks of the alkali felspars.

IV. Products of Pneumatolysis of the Pink Aplite.

These may be listed as follows:—*(a)* The quartz-tourmaline nodules (Pneumatoliths); *(b)* the greisen; *(c)* the kaolin.

The quartz-tourmaline nodules have already been described in the paper cited above. They were developed anteriorly to the greisen, which will now be discussed.

(b) The Greisen.—Subsequent to the consolidation of the aplite fissures in turn were developed and afforded an avenue of escape for the remaining volatile constituents, now much reduced in temperature.

The effects of the volatile constituents are denoted by the presence of quartz veins and the occurrence of small quantities of greisen developed as an alteration of the aplite.

The quartz of the vein material has crystallized in the characteristic prismatic crystals capped with pyramid faces. A section across a quartz vein to the original aplite shows in succession-quartz, an alteration product of the aplite which proves to be a greisen, and this grades into an unaltered aplite.

In hand specimens the greisen has a porous, fine-grained. light-greenish appearance, and with the aid of a lens quartz and a lightish-green mica are easily recognized. The porous character of the rock is well marked.

Under the microscope the minerals seen to be present are quartz and muscovite, the latter being slightly greenish in colour, and so is slightly pleochroic.

The muscovite is present in elongated flakes showing good cleavages, and is often present in bunches or tufts, but in all degrees of orientation. In the true greisen replacement of felspar has been complete. A gradational alteration of the aplite occurs, however, and some sections show the incipient greisenization of the felspar.

The quartz of the original aplite is unchanged, but some secondary quartz has been introduced.

(c) The Kaolin.—At a still later stage in pneumatolysis kaolinization of the aplite has occurred. The kaolin is developed in bands along minute fissures, which may contain thin quartz veins, and may be ascribed essentially to the action of superheated water at a lower temperature than that of greisenization.

The evidence of pneumatolysis of the aplite is clearly shown, and the progressive fall in temperature of the pneumatolytic agents is reflected in the change of pneumatolytic product. The order of development of pneumatolytic product in these aplites is in accord with that worked out for other fields.[4]

The formation of muscovite from microcline is doubtless represented by the well-known equation:—

(i.) $3\ K\ AlSi_3O_8 + H_2O \rightarrow H_2\ K\ Al_3\ (SiO_4)_3 + K_2\ SiO_3 + 5\ SiO_2$, and the development of kaolin by

(ii.) $2\ K\ AlSi_3O_8 + 2\ H_2O \rightarrow Al_2O_3\ 2\ SiO_2\ 2\ H_2O + K_2\ SiO_3 + 3\ SiO_2$, or if CO_2 is regarded as an active agent by

(iii.) $2\ K\ AlSi_3O_8 + 2\ H_2O + CO_2 \rightarrow Al_2O_3\ 2\ SiO_2\ 2\ H_2O + K_2CO_3 + 4\ SiO_2$.

The volume changes represented by these equations are for (i.) the development of muscovite and quartz, a volume decrease of 22 per cent.; for (iii.) the production of kaolin and quartz, a volume decrease of 13 per cent.

During the greisenization kaolin can accompany the production of mica, although in general the former is distinctly formed at a lower temperature. If this is so, the porous nature of the greisen can be explained as due to the weathering out of kaolin from the rock. Even so, it is possible that the porosity may in part represent the volume decrease on greisenization, as shown by the preceding equations. It is difficult to understand, however, if this be correct, why the

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[4] *Cf.* Flett, J. S.: Memoir of Geol. Surv. Eng. and Wales, 1909, Geology of Bodmin and St. Austell, p. 118.

quartz solutions in the associated vein did not completely infill the cavities.

V. The Nature and Composition of the White Pegmatite.

The mode of occurrence of these dykes and veins has already been described, including a brief macroscopic description of the various types.

When these rocks were examined microscopically the predominant felspar was found to be albite, and the rock types can now be classed as albitites. The varieties present are quartz-albitites, muscovite-albitites, and an almost pure albitite consisting practically of albite. This rock occurs in veins associated with a quartz-albitite.

(a) Albitite.—$D^{18^\circ}_{4^\circ} = 2{\cdot}622$:—Under the microscope this rock is seen to consist essentially of albite. Accessories are apatite, in hexagonal crystals; zircon, in idiomorphic prisms, showing high polarization colours; and rutile, usually in prismatic forms.

Muscovite is present in small tufts and is usually associated with apatite, zircon, and rutile. The albite is usually subidiomorphic to allotriomorphic. A curious mottled twinning shows up in some sections. This has been described as "chequer albite."(5) In other sections only well-defined albite lamellae are present.

A very small quantity of interstitial quartz is present in the slide.

The chequer structure is due to the presence of irregular interpenetrating twin lamellae. No traces of a mottled character, however, are present on sections parallel to (010). This structure was first described by Becke.(6) Flett and Hughes have noted its development in phenocrysts of volcanic rocks associated with albite of the usual kind.

In the albite rocks under consideration, there is no evidence to suggest albitization of original microcline felspar.

Some albite sections show a transition from normal albite lamellae to the chequer type. Its occurrence, associated with normal albite, both here and in the example given by Flett, appear to negative any secondary origin as a pressure effect.

Its origin is admittedly obscure, but it seems possible that it may be primary, indicating irregular deposition of albite substance during growth. The presence of excess mineralizers may have been effective to this end.

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(5) *Vide* Flett, J. S.: Mem. Geol. Surv. Eng. and Wales, Geology of Newton Abbot, 1913, p. 60. E. W. Hughes: Geol. Mag., Jan., 1917, p. 18.

(6) F. Becke: Denk. Kais. Akad. Wien., vol. lxxv., p. 28, 1906.

The descriptions by Jack [7] and Ransome [8] of the albite present in albitite rocks, described by them, strongly suggest the presence of chequer albite in these rocks.

· *(b) Quartz Albitite.*—$D^{19°}_{4°} = 2{\cdot}640$. This forms the most abundant type, and it is with this rock that the albite is associated. Here the quartz is present as blue opalescent grains as in the main granite. Microscopically, the minerals present are quartz, albite, and as accessories apatite, zircon, and rutile. The latter mineral is present in idiomorphic prismatic crystals and, also, as geniculate twins (twinning plane [101]), giving a sagenite network.

The albite has a refractive index less than Canada Balsam. In sections perpendicular to the albite lamellae, the symmetrical extinction is 16° and on sections showing as untwinned the maximum extinction is 19° from the (001) cleavage. Further confirmation is provided by the extinction given on (010) for the two parts of a Carlsbad twin. The sign of the birefringence is positive.

(c) Muscovite Albitite.—This is developed at Barn Bluff. The rock in hand specimens has an altered appearance. Through the felspar can be seen very small veinlets of quartz, and portions of the felspar show alteration with limonitic material. Muscovite is recognizable. Under the microscope, the minerals present are albite, muscovite, and accessorily, quartz, apatite, zircon, and rutile.

The albite possesses the same characteristics as in the other occurrences, and the peculiar chequer twinning is observed.

Some of the mica is associated with quartz in little tufts and rosettes. Both mica and quartz are probably secondary. Some muscovite, however, is undoubtedly primary. The rock has apparently suffered some change, due to the presence of mineralizers, but the results are not as clearly demarcated as in other examples.

A study of the literature of albite, aplites, or pegmatites indicates that this type of rock is comparatively rare.

Rocks of this type were first described under the name albitite by Turner [9] from Plumas Co., Sierra Nevada. These aplites occur as dykes, and consist essentially of albite in granular aggregates. Quartz is occasionally completely absent, but may occur plentifully in the same dyke. Muscovite may or may not be present. Iron ores and apatite are sparingly distributed, and garnet is an occasional accessory. Duparc

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(7) R. L. Jack: Geol. Surv. S. Austr., Bull. No. 3, 1914, p. 16.

(8) F. L. Ransome: Journ. Wash. Acad. Sci., vol. i., No. 4, 1911, pp. 114-118.

(9) H. W. Turner: 17th Ann, Rep. U.S.G.S., pp. 728, *et seq.*

and Pearce[10] describe albitites from the Northern Urals, where they are associated with gabbro. In these rocks the albite is developed intergrown with a little quartz.

It is to be noted that both these occurrences are associated with more or less basic rocks, *e.g.*, in the Sierra Nevada with serpentine, and in the Northern Urals with gabbroid masses.

In Australia rocks of this nature have been found in Western and South Australia. Maitland[11] described a pegmatite from the Pilbarra region. The constituents appear to be albite, quartz, garnet, and cassiterite. From Eyre Peninsula, South Australia, R. L. Jack[12] describes dyke rocks of aplitic habit consisting, essentially, of albite with small amounts of quartz, muscovite, apatite, and magnetite. From the descriptions given, the albite evidently possesses the peculiar chequer structure. In one instance there is a remarkable association of wernerite with the albitite, the scapolite being developed in long prismatic crystals.

The association of the Western Australian albitite is with granite, whilst the Eyre Peninsula rock is intrusive into metamorphosed sedimentary beds, but granites are developed at hand.

A partial analysis of an albitite from Cape Willoughby has been made. This is tabulated below, and for comparison the analyses of a number of other albitite rocks are listed with it :—

	I. Sierra Nevada.	II. N. Urals.	III. Pilbarra.	IV. Eyre Pen.	V. Cape Willoughby.
SiO_2	66·54	66·09	68·36	66·13	68·39
TiO_2	n.d.	0·23	0·07	0·31	n.d.
Al_2O_3	n.d.	18·85	18·74	19·92	n.d.
Fe_2O_3	n.d.	0·91	—	0·60	n.d.
FeO	n.d.	—	1·15	0·19	n.d.
MnO	n.d.	—	0·45	—	n.d.
MgO	0·77	1·53	0·54	0·12	n.d.
CaO	0·43	1·09	0·39	0·57	0·65
Na_2O	10·28	10·84	10·22	10·83	11·22
K_2O	0·89	0·48	0·07	1·02	0·21
H_2O	n.d.	1·17	0·03	0·44	0·45
P_2O_5	n.d.	—	—	0·09	n.d.

I. H. W. Turner: 17th Ann. Report U.S.G.S., 1895-6, p. 728.
II. Duparc et Pearce: Compt. Rendu., 140, 1905, 1614.
III. A. Gibb Maitland: Bull. 40, Geol. Surv. W. Austr., p. 100.
IV. R. L. Jack[13]: Bull. 3, Geol. Surv. S. Austr., p. 16.
V. C. Willoughby albitite.

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(10) Duparc et Pearce: Compt. Rendu., 140, 1905, 1614.

(11) A. Gibb Maitland: Bull. No. 40, Geol. Surv. W. Austr., pp. 100-102.

(12) R. L. Jack: Bull. No. 3, Geol. Surv. S. Austr., pp. 15, 16.

(13) The abnormally high content of Na_2O (13·48%) reported for the Miltalie albitite casts suspicion on its reliability.

VI. The Relations of the Rock Types.

In the accompanying table the mineral constitution of the rock types is shown.

The sign + indicates the presence of the mineral as a constant feature, and often in relative abundance.

The sign − indicates that the mineral is sparingly present, and may be absent.

The two combined, ±, indicate that varieties of the one rock type may show the variation indicated:—

Rock Type.	Iron Ores.	Biotite.	Oligoclase - Andesine, or Basic Oligoclase.	Microcline.	Quartz.	Albite.	Muscovite.	Zircon.	Apatite.	Rutile.
Granite ...	+	+	+	+	+		−	−	−	
Microcline Aplites	−	−		+	+	± (Calcic)	−		−	
Albitites ..					±	+	±	+	+	+

The origin of the aplites, both potassic and sodic (albitite), with the granite remains to be discussed.

Aplites associated with granite rocks consist essentially of alkali felspars and quartz, and occur as dykes or irregular sheets. In distinction from pegmatites they are characteristically fine grained. This fine-grained texture may be inconstant, and with a transition into a coarser type they grade into pegmatites.

Pegmatites appear to differ from aplites only in this, that they are typically coarser grained, and often contain a wider range of accessory minerals, these characteristics being generally assignable to the greater concentration of mineralizers during their crystallization.

These rocks represent the residual magma obtained by fractional crystallization, whether by sinking of crystals, or by a selective filter pressing, or squeezing out of the residual liquid from the crystalline mass of granite composition.

Such residual magma, on the contraction resulting from the cooling of the crystalline mass, is injected into cracks or joints so formed. Where differentiation of the granitic magma followed different lines, we have aplites associated with lamprophyric rocks in complementary relationship.

A review of the literature on granite aplites indicates that these are dominantly potassic, or sodi-potassic.

Of aplites associated with basic rocks our knowledge has increased during the last few years. Such aplites may occur

as salic interstitial masses or segregations within the associated rock, and are often characterized by a micrographic fabric, or they may occur as distinct dykes cutting the igneous mass.

The composition of such aplites is variable. The predominant felspar is very often albite or oligoclase, with quartz. Orthoclase may be absent. Such aplites are therefore often characteristically sodic.

Examples of this type have been described by Elsden,[14] Bowen,[15] Collins,[16] and others.

To be correlated here also are the albite—rich dyke-rocks described by Turner, Duparc and Pearce, and Ransome.[17] The former are associated, as has been noted, with serpentine and gabbro masses respectively. The albite rocks described by Ransome are associated with diorite.

In the micropegmatite of the Purcell Sills,[18] orthoclase is associated with the sodic-plagioclase, and the potassic felspar plays the dominant part in the pegmatites of the Duluth gabbro.[19]

In all these examples the dominant process of differentiation has probably been one of fractional crystallization.

Before discussing the mechanism of the differentiation of the Willoughby aplites and pegmatites, the characteristics of the types will be shortly reviewed. They may be divided into two groups:—

(i). Those characterized by dominant microcline.
(ii). Those characterized by dominant albite.

The microcline aplites consist essentially of fine-grained aggregates of quartz, microcline, and subordinate albite. They may pass locally into a porphyritic type in which phenocrysts of quartz, biotite, and more rarely acid plagioclase are present. Granophyric phenocrysts of microcline and quartz also occur.

The albite pegmatites (albitites) are composed essentially of albite with quartz (quartz albitite), of dominant albite with accessory muscovite (muscovite albitite), and are comparatively coarse grained, sufficiently so to texturally determine them as pegmatites. Microcline appears to be absent.

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[14] J. V. Elsden: Q.J.G.S., 1908, vol. 64, p. 273.

[15] N. L. Bowen: Journ. Geol., 1910, vol. 18, p. 658.

[16] W. H. Collins: Mem. 33, Geol. Surv. Can., 1913, p. 59.

[17] F. L. Ransome: Journ. Wash. Acad. Sci., vol. i., No. 4, 1911, pp. 114-118.

[18] S. J. Schofield: Mus. Bull. 2, Geol. Surv. Can., 1914, pp. 1, *et seq.*

[19] F. F. Grout: Econ. Geol., vol. 13, No. 3, 1918, p. 185.

The mode of differentiation of these rocks can be considered under the following heads:—

A. THE ORIGIN OF THE MICROCLINE—ALBITE APLITES.

The microcline-aplites and albite-pegmatites are the only intrusions within the confines of the granite as exposed. No basic dyke-rocks were seen by the writer. In the country rock, some miles from the granite contact, Prof. Howchin [20] has reported a basic dyke of diabasic composition. The writer, unfortunately, was unable to visit the locality during his visit.

Despite the abundance of aplite associated with the granite, there appears to be a scarcity of other satellitic types of intrusion, such as those of lamprophyric type, which, if present, might suggest complementary differentiation. The field evidence must be taken as it stands, for we have no warrant to assume that such lamprophyric types are present but still uncovered.

This evidence is therefore suggestive that the microcline aplites are direct derivatives of the granite magma by a process of fractional crystallization.

The aplites as now developed in the granite came into their position during the cooling and contraction of the crystalline granitic mass, *viz.*, by intrusion into contraction cracks and fissures. In this respect, therefore, the aplitic intrusions resemble those characteristic of so many granitic masses.

The origin of the albite rich pegmatites which are developed in minor amount within the granite remains to be treated.

B. THE ORIGIN OF THE ALBITITES.

It has been noted in the previous discussion that aplites associated with basic rocks were often highly sodic, but not invariably so. In the case of the Willoughby pegmatites, the sodic type is associated only with granite. Their sodic nature —in some cases they consist almost wholly of albite—is, however, no reason for genetically connecting them with basic rocks. Here again field evidence warrants no such assertion.

Their mode of occurrence is essentially as small dykes cutting the granite. Their possible modes of differentiation can be considered under three heads:—

(a) They represent an immiscible liquid phase separating from the residual magma.

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[20] W. Howchin: Trans. Roy. Soc. S. Austr., 1903, vol. xxvii., pt. i., p. 82.

(*b*) They are of secondary origin, and represent the albitization of original microcline dyke-rocks, this albitization being accomplished by magmatic soda-rich solutions.

(*c*) They represent the "end product" and final differentiate of the residual magma, and are therefore directly related to the potassic-aplites.

(*a*) *An immiscible phase of the liquid residual magma.*—Daly,[21] Grout,[22] and others have resorted to liquid immiscibility to explain certain types of differentiation.

It must be admitted that the evidence for the separation of liquid phases in igneous magmas has not yet been clearly demonstrated, nor has the extensive experimental work on silicate-melts given any indication of such a process.

For the Willoughby albitites it is thought that this mechanism is untenable, for homogenous rock masses abound in which all minerals herein concerned, *viz.*, quartz, microcline, and albite, are associated in a wide range of mixtures. It is to be noted here, however, that the objection raised by Bowen[23] that the formation of a monomineralic rock is generally impossible by liquid immiscibility, owing to the fact that this would necessitate its crystallization at its true melting point—*i.e.*, far above the temperature of the magma, say for albite, 1100° C.—ignores the possibility, theoretically, of albite and a volatile mineralizer (*e.g.*, water) separating as a liquid phase, in which case the *reductio ad absurdum* argument fails.

(*b*) *Albitization of original potassic rocks.*—This view immediately admits the albitites to be of secondary origin and the process of albitization to have been produced by magmatic soda-rich solutions.

As far as the writer is aware, there is no evidence of albitization of the surrounding granite with which the albitites are in contact. Nor does the texture of these rocks suggest such a replacement. Both occurrence and texture are strongly against their derivation from original potassic-aplites.

(*c*) *The albitites represent the final differentiate or end product of the residual magma.*—The writer is of the opinion that the albitites represent the final differentiate of the residual magma.

The intimate relationship of the potassic-aplites and the albite-pegmatites is indicated by the presence, in each, of the

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(21) R. A. Daly: Igneous Rocks and their Origin, p. 226.

(22) F. F. Grout: Econ. Geol., 1918, p. 185.

(23) N. L. Bowen: Journ. Geol., Dec., 1915 (Supplement), p. 80.

blue opalescent quartz so characteristic a feature of the normal granite. They are further related by the presence of albite, which, while the subordinate felspar in the potassic-aplite, is the dominant felspar in the albitites.

The albite-pegmatites are to be distinguished from the potassic-aplites :—

(i.) By their relatively minor development—being limited to a few dyke or pipe-like masses.

(ii.) By their coarse-grained texture—the potassic aplites being predominantly fine grained.

(iii). By the presence of accessory minerals as apatite, zircon, and rutile in relative abundance. Such accessory minerals are practically absent from the microcline aplites.

(iv.) By the absence of biotite.

(v). By the absence of microcline.

Varieties of Albitites.—The predominant type is a coarse-grained quartz-albitite, which may pass into veins of pure albite. The quartz occurs in blue opalescent grains and the albite in Carlsbad twins—also twinned on the albite law. The remaining type is a muscovite-albitite, in which muscovite is associated with albite. The accessory minerals are developed in all types.

The Mechanism of Differentiation.—The residual magma, dominantly potassic in composition, was derived by the fundamental process of differentiation—fractional crystallization. This liquid, by a process of straining off from the crystalline granite, is regarded as occupying subsidiary pools or chambers[24] within the granitic mass. Consequent on such fractional crystallization the residual liquid was enriched in mineralizers, chiefly water.

In the main granite the crystallization of plagioclase was early initiated, and occurred with marked zoning, the varying composition being from andesine to oligoclase. The residual magma was thus enriched in albite molecules relatively to

[24] In granitic masses the evidences of the existence of such magma pools, as stipulated, are principally provided by the occurrence of aplitic or pegmatitic phases with distinctly blended contacts with regard to the granite mass. Crystallization, *in situ*, is therefore demanded. Where contacts between the aplitic or pegmatitic phase and the granite are sharp and well defined crystallization occurred after intrusion from such a magma pool. Many granitic masses show the evidences of two such types of satellitic phases.

anorthite, these latter being selectively locked up in the inner zones of plagioclase.

The non-volatile constituents of the residual magma thus consisted essentially of quartz and microcline and subordinately slightly calcic albite.

With the renewal of crystallization in the residual magma quartz and microcline were early precipitated, the magma being thus constantly depleted in these constituents. That some albite crystallized during this period is also evidenced by the presence of subordinate albite, associated with the microcline and quartz. This albite was still slightly calcic and with crystallization its composition approached pure albite. The amount crystallizing, however, was quite subordinate, and the impoverishment of the still liquid residue in microcline molecules especially occurred.

Nearing the completion of crystallization of such a magma pool, the residual liquid would have markedly changed in composition through such selective crystallization. This residual liquid depleted in potassic constituents would therefore have become highly *sodic*.

By the opening of fissures in the surrounding rock this residual liquid, derived by fractional crystallization from the dominant potassic magma, was strained off from the crystalline mass and solidified in the occupied fissures.

Derived by such a process of fractional crystallization this residual liquid would be:—(i.) Predominantly sodic; (ii.) characterized by an increased concentration of mineralizers.

This process of differentiation receives considerable support from a study of the albitites.

Their coarse-grained texture and the concentration in them of such minerals as zircon, apatite, and rutile are characteristically to be associated with a concentration of mineralizers during crystallization, or, in other words, they are typical end products of differentiation.

It has been noted that some muscovite and quartz in the muscovite-albitites appears to be secondary. This is principally evidenced by the shattering of albite plates by small quartz stringers. This pneumatolytic process is intimately related to the concentration of mineralizers during the crystallization of the rock. The shattering of albite plates by quartz strings and the production of muscovite can be relegated to a late stage of crystallization, *i.e.*, at or near the completion of crystallization. The muscovite, indeed, may represent the hydrolysis of potential microcline-felspar.

The scheme of differentiation can be summarized in the appended chart:—

Chonolitic Mass. Differentiation *in situ*.	Residual Magma → Albite Pegmatites. (dominantly sodic).
	↑
	Microcline Albite Aplites (differentiation may cease here).
	↑
	Residual Magma (dominantly potassic).
	↑
	Granite [Adamellite].
Salic differentiate from a batholitic Magma.	↑
	Granitic Magma.
	↑

The very minor amount of albitite in comparison to the development of potassic-aplite is here again emphasized. If this relation be preserved at depth, it follows that the composition of the residual magma lies very close to that of the potassic-aplites.

In this connection the writer would point out that the differentiation of the residual magma may be controlled by a mechanical factor. Where the residual magma has been forced into fissures and caused to rapidly cool, further differentiation may be inhibited and the magma solidify as a crystalline aggregate of quartz, microcline, and subordinate albite.

On the other hand, the filtering of the residual magma into a subsidiary pool without rapid change of temperature and its slow crystallization undisturbed, then fractional crystallization may take place with the production of a small amount of residual liquid, enriched in mineralizers and of composition markedly different from that of the original residual magma.

Movement at this stage would result in the straining off of the small amount of residual liquid, giving rise to intrusions of highly sodic-pegmatite.

In composition, the potassic-aplites so derived would differ but slightly from that representing the composition of the residual magma.

We have here in miniature the outlines of a process which, on a grander scale, Smyth [25] has suggested for the differentiation of alkaline from subalkaline magmas.

Review of differentiation.—The predominant potassic-aplites with the minor sodic-pegmatites, plus the volatile mineralizers, represent, approximately, the residual magma derived from the fractional crystallization of the granitic magma.

This residual magma under favourable conditions underwent further differentiation, yielding predominant potassic-aplites as the fractionally crystallized portion and the minor sodic-pegmatites as the residual liquid highly enriched in mineralizers, now represented by the presence of the accessory minerals.

In the main, the mechanism of differentiation appears to have been one of straining off of a residual liquid from a crystalline mass.

It may well be that the extent of differentiation in such cases is dependent on the magma chamber remaining undisturbed by external agencies for sufficiently long periods to allow of delicate adjustment of equilibrium in the presence of volatile mineralizers.

With the crystallization of the albite-pegmatites differentiation appears to have closed. At a late stage in the consolidation of the microcline-aplite, the pneumatolytic action of mineralizers is represented by the quartz-tourmaline pneumatoliths, and at a still later stage greisenization and kaolinization were developed.

Correlation with other Australian Albitites.—These albite-pegmatites, or albitites, are to be correlated with the previously-described albitites from Pilbarra region, Western Australia, and the albitites from Eyre Peninsula. In all three cases their association appears to be with granitic rocks. In the case of the Pilbarra rock, the pegmatite is tin bearing. The Eyre Peninsula albitites are remarkable for the association in one case of wernerite in long prismatic crystals.

VII. General Discussion.

Form of the Intrusion.—It has been noted in the Introduction that the granite is distinctly transgressive to the surrounding schists and quartzites. The seaward extension of the granite is not known. Some evidence of the underground extension of the granite, in an horizontal direction, is afforded

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[25] C. H. Smyth, jr.: Amer. Jour. Sci., 1913, 36, p. 42.

by the occurrence of a pegmatite dyke 8 miles from the granite headland. This is genetically related to the Cape Willoughby massif, and carries gem tourmalines. With the crystallization of the granite and associated dyke rocks, the igneous cycle appears to have closed.

The foregoing data admittedly are insufficient to determine the form of the intrusion, yet the writer ventures to place it in the class of chonolite, as described by Daly and defined by him as an igneous body:—*(a)* Injected into dislocated rock of any kind stratified or not; and *(b)* of shape and relations irregular in the sense that they are not those of a true dyke, vein sheet, laccolite, bysmalite, or neck; and *(c)* composed of magma, either passively squeezed into a subterranean or orogenic chamber, or actively forcing apart the country rocks.

The chonolite type, therefore, covers a wide range of intrusions whose form cannot be considered well characterized. It is thought that, for the Willoughby massif, the evidences of underground extension, horizontally, and the apparent rapid closing of the igneous cycle are not favourable to a batholitic nature.

The relation of the Cape Willoughby Massif to other South Australian Intrusions.—Kangaroo Island is separated from the mainland of Jervis Peninsula by the narrow strait of Backstairs Passage. The island really forms a continuation of the Mount Lofty Range, cut across by the Backstairs Passage, which is probably a block-faulted area. The extension of the island in a westerly direction is related to the strike of the axis of Palaeozoic folding, and is perhaps emphasized by the fact that the late Tertiary fault scarps are developed parallel to the strike of the Palaeozoic folding.

The structure of the Mount Lofty Ranges has been shown to consist of a central geological axis of Pre-Cambrian schists and intrusive rocks with a north-east-south-west strike,[26] and developed, anticlinorially, a series of sediments dipping easterly and westerly from this axis. These sediments on the western side are only slightly altered, whilst their eastern representatives are markedly metamorphosed, being represented by quartzites, schists, and marbles.

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(26) W. Howchin: Trans. Roy. Soc. S. Austr., vol. xxviii., 1904, pp. 253-280. W. Howchin: *Ibid*, vol. xxx., 1906, pp. 227-262. W. Howchin: Aus. Ass. Adv. Sci., 1907, Sect. C, pp. 414-442.

The easternmost beds have been invaded by igneous intrusions which are comparatively absent from the western side of the axis.[27]

These sedimentary beds contain an interstratified glacial tillite. They have been designated as Lower Cambrian by Professor Howchin, but the possibility of their being Proterozoic must not be denied.

Age of the Intrusion.—The granitic mass of Cape Willoughby is intrusive into the eastern representatives of this series. Howchin has shown that the late Palaeozoic (Permo-Carboniferous) glacial deposits overlie the old metamorphic rocks of eastern Kangaroo Island, and are represented near Cape Willoughby itself. The presence of these glacial beds indicates that already the granite was exposed in Permo-Carboniferous times. If the intruded beds are to be relegated to the Proterozoic, as has been suggested for their western representatives, then the age of the granite can only be rigidly defined as Post Proterozoic and Pre Permo-Carboniferous.

On further analysis, however, it would appear that these limits can be somewhat narrowed. It is clear that in Permo-Carboniferous times the granite was exposed at the surface. The vast amount of erosion that would be required for its exposure indicates that it was intruded considerably prior to Permo-Carboniferous times. On the other hand, it is clear that the first great orogenic movements in this area subsequent to deposition of the intruded beds developed only after Cambrian time, for the Proterozoic age of these beds is dependent on a disconformity between their western representatives and the Cambrian Archaeocyathinae limestones.

The absence of Ordovician beds at the edges of the Cambrian geosyncline points to the folding of this geosyncline at the close of the Cambrian or in Ordovician time.

The development of the Mount Lofty Ranges as a huge anticlinorium with a pronounced westerly overthrust and the occurrence of an eastern zone of igneous intrusion is suggestive that these igneous intrusions are related to the folding.

Since Ordovician times no orogenic movements have disturbed this area to the present day. The evidence of inclusions of country rock in the granite indicates that partial

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(27) This view of the structure of the Mount Lofty Ranges has been denied by some observers, particularly W. G. Woolnough. Remarkably clear evidence of the anticlinorial character of the ranges can be obtained in the Inman Valley, where an easterly succession beginning with the great angular unconformity of the Grey Spur can be traced through to Victor Harbour. More complicated but none the less clear is the succession in the Williamstown-Mount Crawford area, Barossa. The possible Proterozoic age of the westernmost beds affects this question not at all.

metamorphism had already been effected prior to intrusion. This is in harmony with the view that regional metamorphism had been induced in the period of maximum intensity of folding, and that the igneous intrusions, while directly related to the orogenic movements, were developed at the close of the folding period, when movement was of a broad and relatively simple type.

The mass of Cape Willoughby is to be correlated—based on the observations of Mr. W. R. Browne, B.Sc., detailed in a forthcoming paper—with the granite masses of Victor Harbour and Port Elliot, both on field and petrological evidence.

Conclusion.

In conclusion the writer would suggest that:—

(i.) The masses of Cape Willoughby, Victor Harbour, and Port Elliot represent chonolitic masses of limited surface extent, which are connected at depth to a single batholitic chamber.

(ii.) These chonolites are arranged along a zone parallel to the strike direction of the older Palaeozoic folding.

(iii.) These chonolitic intrusions, whilst related to the orogenic movements, were developed only at the close of the folding epoch, when movements were of a comparatively broad and simple type.

The writer is indebted to Mr. W. R. Browne, B.Sc., for much help and advice during the preparation of this paper.

DESCRIPTION OF PLATES.

Plate XXX.

View of granite outcrop forming part of the Cape Willoughby headland.

Plate XXXI.

Fig. 1. Sagenite web of rutile in quartz albitite. Magn., 50 diams.

Fig. 2. A typical section of chequer structure in albite of the albitites. Magn., 53 diams. + nicols.

Australian Coleoptera—Part 1.

By Albert H. Elston, F.E.S.

[Read September 11, 1919.]

PAUSSIDAE.

Arthropterus articularis, n. sp. (fig. 1).

Dark castaneous, elytra slightly paler. With very short and sparse setae, except on sides and legs where they are more numerous and longer.

Head wide, slight interocular depression, with numerous clearly-defined but somewhat irregular punctures; sides tuberculate behind the eyes. Antennae with more numerous punctures being somwhat subrugose at sides, first joint stout, slightly longer than second and third combined, second about three times wide as long, fourth to ninth each about twice as wide as long and almost semicircular, the tenth about as long as eighth and ninth combined, almost circular, its apex slightly more rounded than base. *Prothorax* slightly narrower than head, apex somewhat wider than base; disk flattened, median line clearly defined, margins slightly reflexed, more so at basal angles than elsewhere, with numerous well-defined but somewhat irregular and small punctures. *Scutellum* subtriangular. *Elytra* about thrice as long as prothorax, with irregular subseriate punctures, smaller than those on prothorax and almost disappearing posteriorly; apical membrane about as long as scutellum. Front *tibiae* each with a large apical spur overhanging an apical notch, the middle and hind ones are similarly furnished but much less conspicuously, and all strongly curve inwards on underside near base. Length, 5-5½ mm.; width, 3-3½ mm. Type, in author's collection; cotype, I. 10842, in South Australian Museum.

Hab.—South Australia: Quorn (A. H. Elston), Lake Callabonna (A. Zeitz).

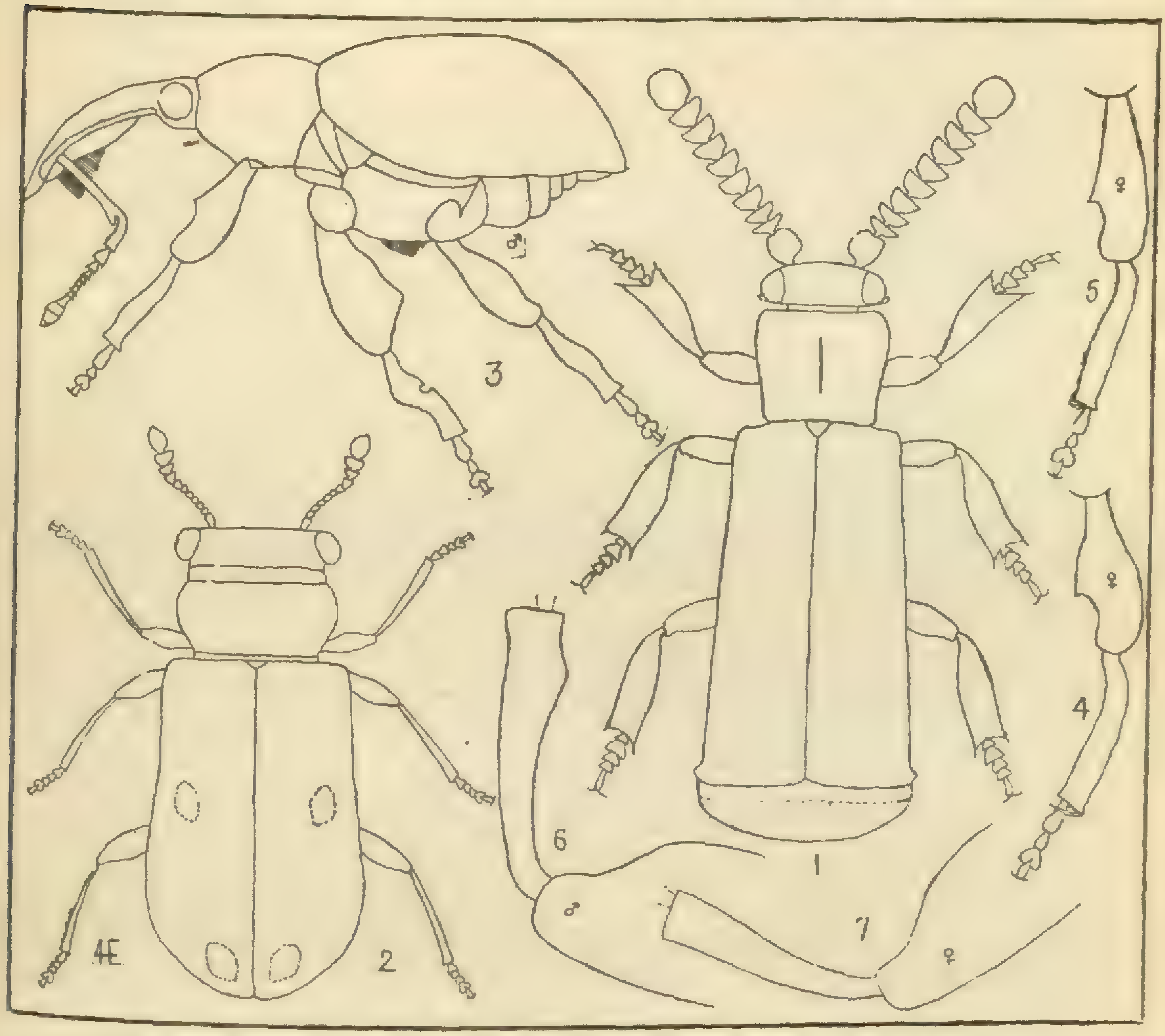
This species is easily distinguished by the apical joint of the antennae, which is almost circular, and the fourth to ninth which are somewhat semicircular in shape. On some specimens the interocular depression is more pronounced than on others, and those taken at Lake Callabonna are much darker in colour (although this is probably due to age), the prothorax and head being a dark brown, and in being more hairy, especially on antennae. The elytral pubescence is semi-erect and very short, but is quite distinct when viewed from the sides. On each of the front tibiae the apical spur is much larger than the free spur, but on the others the free spur is the more conspicuous

of the two, and the second and third joints of the tarsi are strongly dilated.

CLERIDAE.

Lemidia basiflava, n. sp.

Glossy black; front of head, antennae, base of elytra, and parts of front and middle legs flavous, hind legs black, the knees all more or less pale. Sparsely clothed with moderately



1, *Arthropterus articularis*, n. sp. 2, *Lemidia variabilis*, n. sp. 3, *Diethusa insignita*, n. sp. 4, Front leg, *D. insignita*, n. sp, ♀. 5, Front leg, *D. mollis*, Lea, ♀. 6, Hind leg, *Edusa pulchra*, n. sp., ♂. 7, Hind leg, *E. pulchra*, n. sp., ♀.

long straggling hairs, becoming shorter, more or less erect and seriate on elytra.

Head wide, almost impunctate with a few subrugose punctures at sides near ocular suture, inter-ocular impressions distinct. *Prothorax* about as long as wide, sides rather suddenly inflated at the middle, distinctly narrower than

head, constricted slightly more towards apex than near base, with a transverse impression near apex and a moderately large depression near middle of base, with a few scattered punctures. *Elytra* about as wide as head, sides near base parallel, but becoming gradually dilated behind the middle then rounded at apex, with rows of rather large clearly-defined punctures becoming smaller posteriorly and disappearing at apex. Length, 4 mm.

Hab.—South Australia: Mount Lofty Ranges (R. J. Burton, S. H. Curnow, J. G. O. Tepper, A. H. Elston), Kangaroo Island (A. M. Lea). Type, I. 10833, in South Australian Museum.

At first this was thought to be a variety of *exilis*, but it differs from that species in having the prothorax black, the sub-basal depression less transverse, and the elytral punctures in rows and more clearly defined. In some of the specimens the apical joints of the antennae are more or less infuscate; the flavous markings at base extend from near the suture (on two specimens they touch it) to the margin, the pale basal portion is confined to the depth of elytra, and when viewed from behind is barely perceptible. In Lea's table [1] this species would be associated with *elongata* from which it differs in being smaller, glossy black, the flavous portion of head more conspicuous, and the post-median fascia absent.

L. basiflava, var. fasciata, n. var.

Differs from above form in having the legs flavous, except that the hind tarsi and apex of tibiae are infuscate, and a somewhat irregular flavous fascia situated at the middle of the elytra, beginning near the suture and extending a little more than half way across. On one specimen the legs are much the same as on the type form and its fascia is represented by two semi-detached spots, and on two the apical joints of the antennae are infuscate, one specimen has a tinge of red near the apex of the prothorax. Length, 4 mm.

Hab.—South Australia: Kangaroo Island (A. M. Lea), Mount Lofty Ranges (A. H. Elston).

L. auricoma, n. sp.

Piceous-brown, head and prothorax black with a slight metallic gloss; mandibles, antennae, palpi, and legs flavous, the hind tarsi more or less infuscate; elytra with a pale median fascia and pale markings basal and apical. Upper-surface with long, straggling, pale hairs becoming shorter and semi-erect on elytra.

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(1) A. S. E. Belg., 1907, p. 334.

Head wide with rather sparse punctures, interocular impressions feeble. *Prothorax* about as long as wide, narrower than head with sparse punctures more or less concealed, but in places subconfluent, sides dilated near the middle, with transverse impressions subapical and subbasal. *Elytra* wider than prothorax, sides parallel but becoming slightly dilated towards the apex, with numerous well-defined punctures becoming smaller posteriorly and disappearing at apex. Length, 3 mm.

Hab.—Queensland: Cairns district (F. P. Dodd). Type, I. 10832, in South Australian Museum.

The pale markings at base differ, on some of the specimens there is a subtriangular patch along the suture of each elytron connected with the shoulders, but on others the basal markings are absent or very ill defined. The median fascia is narrow near the sides and is rather suddenly dilated near the suture, but it does not quite touch the sides or suture. The apical markings appear to be always present but are not so sharply defined as the median fascia, they are sometimes obscure and continued along the suture and sides, but not touching the median fascia. In Lea's table the typical form would be referred to *III* and there associated with *flavifrons*, from which it differs in being smaller and having the front of head and prothorax black, the legs flavous, and elytral punctures not so clearly defined. The specimens with the basal markings absent would be referred to another section altogether, *IIII*. Elytra with pale markings median and apical, or subapical.

L. auricoma, var. flaviventris, n. var.

Differs from the previous species in having front of head and abdomen flavous.

L. variabilis, n. sp. (fig. 2).

Black with a bluish or purple gloss, the elytra conspicuously purple and furnished with two median and two subapical flavous spots; antennae flavous, the basal and several of the apical joints infuscated. Upper-surface sparsely clothed with straggling, semi-erect hairs, becoming shorter and more erect towards apex of elytra.

Head rather wide and covered with small clearly-defined punctures becoming subrugose in front, interocular depression distinct. *Prothorax* transverse, sides strongly dilated in middle, rather narrower than head with a few small punctures and a subapical and subbasal transverse impression. *Elytra* wider than prothorax, about twice as long as base, sides

parallel near base and becoming dilated posteriorly, with moderately large and rather dense punctures becoming smaller posteriorly. Length, 4-5 mm.

Hab.—Queensland: Cairns district (F. P. Dodd). Type, I. 10831, in South Australian Museum.

This appears to be a rather variable species; there are four specimens in front of me and they all differ as regards the shape and size of the spots. In two the median spots are situated about midway between the suture and the margin, whilst in the others they are entirely absent. The subapical spots are fairly regular, and are placed quite close to the suture but do not touch it. On the head the interocular depression varies, the two shallow foveae being more conspicuous on some specimens than on others. In Lea's table of *Lemidia* this species would be inserted after *flavifrons* as *lll.* Elytra with pale markings submedian and apical or subapical.

L. flavicollis, n. sp.

Shining black; prothorax, antennae, palpi, and legs flavous, hind tarsi infuscate. Clothed with rather long, straggling, and mostly black hairs, becoming shorter and more or less erect on elytra.

Head wide, base and sides with a few small punctures, interocular foveae feeble. *Prothorax* slightly transverse, sides inflated at the middle, distinctly narrower than head, surface almost impunctate with a transverse subapical and subbasal impression. *Elytra* at base about as wide as head, sides near base parallel becoming dilated towards apex, with irregular rows of shallow punctures becoming smaller and disappearing posteriorly. Length, 3-4 mm.

Hab.—Queensland: Cairns district (F. P. Dodd). Type, I. 10830, in South Australian Museum.

In Lea's table this species would be associated with *L. pictipes*, Blackb., from which it differs in being somewhat shorter, antennae entirely pale, elytra with sparser and darker clothing, and with smaller and fewer punctures not extending so far towards apex, the size of the elytral punctures appear to vary on the six specimens before me. The hind tarsi appear to be always infuscated, the others sometimes have the apical joint infuscate, and on one specimen the middle tarsi are infuscate.

CURCULIONIDAE.

Diethusa insignita, n. sp. (fig. 3).

♂. Dark brown with apical part of rostrum, antennae, and parts of legs paler. Densely clothed with soft scales on

the upper-surface, mostly sooty-brown interspersed with white, the under-surface with uniformly white ones.

Rostrum fully half as wide as head and about the length of the prothorax, tapering slightly towards apex, with dense punctures more or less concealed behind the antennae but distinct in front, a conspicuous flange on each side about the middle, each flange rendered more conspicuous by a fascicle of long pale clothing; scape thin, slightly thickened towards apex, about as long as funicle, inserted about one-third from apex of rostrum, first joint of funicle nearly as long as second and third combined. *Prothorax* moderately transverse with dense more or less concealed punctures. *Elytra* subcordate, distinctly wider than prothorax, base trisinuate, with regular series of large partially concealed punctures, interstices wide and even. *Metasternum* with a large deep excavation from its base, and continuing to near the apex of the first segment of the abdomen; between the middle and hind coxae, on each side an obtuse elevation crowned with a conspicuous fascicle. *Abdomen* with apex of last segment furnished with a small fascicle of pale clothing. *Femora* robust, dentate, the tooth on each of the middle pair considerably dilated; middle tibiae distorted. Length (♂, ♀), 4-5 mm.

♀. Differs in being lighter in colour; rostrum longer, thinner, paler, with punctures concealed only near base, and antennae inserted somewhat nearer middle; metasternum and abdomen without the excavation and fascicles, abdomen more convex, metasternum with a slight depression; the middle femora are less robust with the tooth smaller; middle tibiae are less distorted and at the top of the apex a spur is present that slightly diverges from the length of the apex.

Hab.—South Australia: Quorn (A. H. Elston). Type, in author's collection, cotype, I. 10835, in South Australian Museum.

This species is the most distinct in the genus and is easily distingushed by the fasciculate processes on the rostrum and metasternum of the male. The only other species in the allied genera that has fascicles on the metasternum is *Melanterius pectoralis*, Lea, whose male has only a slight depression, whereas in the present species the depression is deep and the fascicles are bent over at their apices, which are nearly touching, and so forming an arch. The strongly dilated femora and distorted tibiae of the middle legs are also characteristic. The female in general appearance closely resembles the female of *D. mollis*, Lea, but with the front and middle tibiae different at apices; in the former species the spur is inserted about the middle of the apex and not diverging from it to any great extent, (fig. 5), its clothing on the upper-surface is

rather less variegated, and on the under-surface the scales are much the same as on the upper-surface; but on the present species the scales on the under-surface are decidedly smaller than those on the upper, and the spur on the front and middle tibiae is inserted at the top of the apex and continuing to its length, diverging from it at an angle of nearly thirty-five degrees (fig. 4).

CHRYSOMELIDAE.

Edusa pulchra, n. sp.

♂. Metallic-green or greenish-blue with a coppery gloss in parts; labrum, palpi, antennae, and legs castaneous; the apex of palpi, apical joints of antennae, and last two joints of tarsi infuscate; the labrum and sides near eyes furnished with pale depressed setae, and the front angles of prothorax pubescent. Under-surface metallic-green with coppery gloss and lightly clothed with pale pubescence, sparse in middle and somewhat dense at sides.

Head with numerous clearly-defined punctures, except at base of antennae, and a slight depression at the occiput. Antennae rather long with second joint about half as long as third. *Prothorax* with front angles acute, sides subsinuate, punctures as on head but becoming denser at margins. *Scutellum* transverse and almost impunctate. *Elytra* almost parallel-sided to beyond the middle, with dense punctures set in somewhat irregular rows, some of them confluent at the sides. *Abdomen* with a few scattered punctures, and the apical segment has a shallow transverse depression. The hind *tibiae* are suddenly dilated near apex (fig. 6). Length (♂, ♀), 5-6 mm.

♀. Differs in being more robust, the hind tibiae not suddenly dilated near apex (fig. 7), first joint of front tarsi smaller, the abdomen more convex and without the subapical depression, and more pubescent.

Hab.—South Australia: Quorn (A. H. Elston). Type, in author's collection, cotype, I. 10834, in South Australian Museum.

This apparently belongs to the glabrous group of *Edusa* and in Lea's table [2] would be referred to C *q*, but that the sides of its prothorax are almost straight in the middle, hence it could not be referred to either *angustula* or *heterodoxa*; in general appearance it is like a rather robust *heterodoxa*, but the abdomen is metallic and its fifth segment is different in the male.

(2) Trans. Roy. Soc. S. Austr., 1915, p. 194.

Additions to the Flora of South Australia. No. 16.

By J. M. Black.

[Read October 9, 1919.]

Plate XXXII.

Gramineae.

Dactyloctenium aegyptiacum, Willd. (*Eleusine aegyptiaca*, Pers.) Mount Deputy, near Mount Eba H.S. (Dist. W; G. Taylor).

**Lamarckia aurea*, Moench. Nuccaleena Mine, near Moolooloo (E. H. Ising). The most northerly record for this grass.

Cyperaceae.

Scirpus littoralis, Schrad. Billakalina Well, 20 miles west of Coward Springs (Dist. C; Dr. G. Taylor, May, 1919).

Cyperus distachyus, All. (Plate xxxii.) Coward Springs (Dr. G. Taylor, May, 1919); Nilpena (R. Helms, May 2, 1891, in the Tate Herb.). The latter is evidently the same plant as that collected at Coward Springs, but some of the spikelets are twin, whereas they are always solitary in Dr. Taylor's specimen. Helms' plant was listed by Mueller and Tate (these Trans., xvi., part 2, 379, ann. 1896) as "*C. laevigatus*, L., a slender form with some of the spikelets solitary." *C. distachyus*, All. (*C. junciformis*, Cav.), is sometimes treated as a variety of *C. laevigatus*, but it appears to be well distinguished by having fewer spikelets (2-5) in the cluster, the glumes dark-red instead of white and the nut only one-third (instead of one-half) shorter than the glume. Our plant agrees with the description in all particulars except that, so far as our present material goes, the spikelets are either solitary or only 2 in the cluster. The Tate Herbarium contains a specimen labelled *C. laevigatus*, from Middleton Creek (Miss Hussey, Feb., 1898), with white spikelets in clusters of 8-16. The same species is recorded in Max Koch's list of plants from Mount Lyndhurst run (these Trans., xxii., 116, ann. 1898). When Professor Tate's flora was published, neither species had been recorded for South Australia. *C. distachyus* is a Mediterranean plant, but it is doubtless native here.

CASUARINACEAE.

Casuarina stricta, Ait., and *C. distyla*, *Vent.* (Plate xxxii). The difference between the male flowers of these 2 species is very marked. In the former the 2 bracteoles are deciduous, coherent at the summit by their cilia, and anterior rather than lateral; in *C. distyla* they are persistent, distinct, and lateral. The 2 perianth-segments of *C. stricta* are connate and have the appearance of a single, flattish bracteole, notched at the summit and pubescent on the 2 midnerves; they are enclosed within the summit of the 2 bracteoles and are posterior in position, *i.e.*, they are placed against the inner face of the stamen and next to the axis of the whorl. In *C. distyla* the perianth-segments are opposite and quite free; one is anterior and the other posterior. In *C. stricta* the bracteoles and perianth-segments cohere to each other on the summit of the ripening anther and usually fall off in one piece. The bracteoles are evidently the "valvulae calycis exteriores" of Labillardière (Nov. Holl. pl. spec. ii., 67, t. 218), and the perianth-segments are his "valvulae binae interiores," from which he named the species *C. quadrivalvis* (=*C. stricta*).

It is probable than an examination of the male flowers of *Casuarina*, which has only been attempted in one or two instances, would help materially in the satisfactory determination of species. It is essentially a task for those who can examine living specimens, because the delicacy of the organs renders the investigation of dried material very difficult, a fact which is noted by Bentham in his great work.

PROTEACEAE.

Hakea ulicina, R. Br., var. *flexilis*, F. v. M. Yurgo, near Karoonda (Dist. M; H. W. Andrew).

SANTALACEAE.

Choretrum glomeratum, R. Br. Yurgo, near Karoonda (Dist. M; H. W. Andrew).

POLYGONACEAE.

Muehlenbeckia Cunninghamii, F. v. M. Miller Creek (Dist. W; G. Taylor).

CHENOPODIACEAE.

Atriplex rhagodioides, F. v. M. Walebing, near Kingoonya (Dist. W; G. Taylor).

Bassia longicuspis, F. v. M. Nuccaleena Mine, near Moolooloo (E. H. Ising). This long-spined species is the "Bindy-eye" of the Far Northern settlers.

PORTULACACEAE.

Anacampseros australiana, J. M. Black. Moolooloo, "growing in a rocky gully" (E. H. Ising).

CARYOPHYLLACEAE.

Polycarpon tetraphyllum, L. Moolooloo (Dist. S; E. H. Ising).

PAPAVERACEAE.

Papaver aculeatum, Thumb. Robe (Dist. T or G; C. D. Black); Moolooloo (Dist. S; E. H. Ising). Apparently a very rare plant. The Robe specimen is 20 cm. high, that from Moolooloo only 4 cm.

CRASSULACEAE.

Crassula colorata, (Nees) Ostenf. (*Tillaea acuminata*, F. M. Reader). Moolooloo (E. H. Ising).

LEGUMINOSAE.

Glycyrrhiza acanthocarpa, (Lindl.), combin. nov. Renmark, River Murray. Flowers December-April; fruits April-May. A shrub 60-80 cm. high, much branched, with thick rootstock; the solitary seed is compressed-obovoid, shining, dull green mottled with brown. The anther-cells are confluent at the summit, and the anterior valve is smaller than the posterior one in all the anthers, of which 5 are smaller and on shorter filaments.—*Indigofera acanthocarpa*, Lindl., in Mitch. Three Exped., ii., 17 (1839); *Clidanthera psoraleoides*, R. Br., App. Sturt Exped. Centr. Aust., ii., 73 (1849); *Psoralea acanthocarpa*, F. v. M., Fragm., iii., 45 (1862); *Glycyrrhiza psoraleoides*, Benth., Fl. Aust., ii., 225 (1864).

Acacia stenophylla, A. Cunn. Kingoonya (Dist. W; G. Taylor); also Yankee Gunyah, 10 miles west of Coward Springs.

A. tarculensis, J. M. Black. Pera Rockhole (near Lake Labyrinth); Tomato Rocks (red felspar porphyries 15 miles south of Kingoonya; G. Taylor).

Aotus villosa, Sm. Karoonda (Dist. M; H. W. Andrew).

**Medicago minima*, Grufb., var. *brachyodon*, Reichb. (*M. brachyacantha*, A. Kern.). A specimen of this short-spined form which has established itself at Millicent, and which has already been referred to in these Trans., xlii., 174

(1918), was submitted to the botanists of the Muséum d'histoire naturelle, Paris, and determined as above.

Rutaceae.

Microcybe multiflora, Turcz. Yurgo, near Karoonda (H. W. Andrew).

Euphorbiaceae.

Phyllanthus lacunarius, F. v. M. Walebing Swamp, near Kingoonya (Dist. W; G. Taylor).

Euphorbia Wheeleri, Baill. Moolooloo (Dist. S; E. H. Ising).

Dilleniaceae.

Hibbertia crispula, J. M. Black. Ooldea Soak (May, 1919; G. Taylor). This specimen contains 2 fruiting carpels; pericarp dehiscing down the inner angle; hairlike segments of the arillus extending beyond the seed.

Frankeniaceae.

Frankenia serpyllifolia, Lindl. Murrayville, Vict. (H. B. Williamson). The broad-leaved form. This is by far the most southerly locality recorded for this species, and points to the probability of its being found in our trans-Murray country.

F. fruticulosa, DC. Murrayville, Vict. (H. B. Williamson). This species has hitherto been collected only along our coastline.

Myrtaceae.

Eucalyptus fasciculosa, F. v. M. Ashbourne (H. W. Andrew). Mr. Andrew says:—"Erect tree about 20 m. high; bark white on the upper part of the stem, mottled below; called locally Pink Gum or Mountain Gum." The leaves are dark green on both sides. The height is quite double that which *E. fasciculosa* usually assumes in the Mount Lofty Range (6-10 m.), where it grows mostly in poor soil and with a more or less crooked stem. The height and straight growth of the tree at Ashbourne bring it near *E. paniculata*, Sm. The outer stamens are barren and the anthers open in terminal pores. Also from Coonalpyn (Dist. T; W. J. Spafford).

E. dumosa, A. Cunn. In his Critical Revision of the Genus Eucalyptus, iv., 220 (1919), Mr. J. H. Maiden has restored *E. dumosa* to specific rank, in accordance with Bentham's treatment, instead of making it a variety of *E. incrassata*, Labill. Most Australian botanists will probably welcome this decision. The two species, at least in their South

Australian forms, are very distinct. *E. aumosa* includes var. *conglobata*, Benth., which is common at Port Lincoln and has clustered, sessile flowers.

Rubiaceae.

Galium Gaudichaudii, DC. Parachilna Gap (Dist S; E. H. Ising).

Goodeniaceae.

Goodenia vernicosa, J. M. Black. Parachilna Gap (E. H. Ising).

Compositae.

Helichrysum ambiguum, Turcz. If all the forms with solitary terminal flowerheads on woolly peduncles, ciliate or fringed involucral bracts, pappus-bristles plumose towards the summit, and female flowers usually devoid of pappus are to be placed in this species, then it becomes one of great variability. In the Tate Herb. is a specimen from Barrow Range, W. Austr. (R. Helms, 19/8/91), with soft, white-woolly appressed leaves only 4-8 mm. long, female flowers 4-toothed, the bisexual ones with 12-14 fragile pappus-bristles, the style swollen and hard at base. This form is probably near the type (which was collected by Drummond in Western Australia), and it bears a remarkable external resemblance to *Calocephalus Dittrichii*, F. v. M. Specimens from Idracowra, Finke River, N.T. (Horn Expedition), and Depôt Sandhills, Finke River (S. A. White), agree with the above in most respects, but the pappus-bristles are 6-9, and much dilated at base. Then there are specimens with stiff greenish leaves, glandular-scabrous above and more or less woolly below, from Ilapilla Gorge, N.T. (Horn Expedition); between Ferdinand River and Mount Watson (Dist. W; R. Helms); Nuccaleena Mine, near Moolooloo (E. H. Ising); Mount Lyndhurst (H. Koch): all these have pappus-bristles 12-18; female flowers 3-toothed, without pappus (in the heads examined). Probably these represent *H. semicalvum*, F. v. M. (var. *semicalvum*, Benth) The Mount Lyndhurst specimen (Tate Herb.) has leaves 10-35 mm. long and simulates *H. rutidolepis*, DC. More complete material may some day furnish characters for dividing these plants into 2 or more species. The achenes are slightly contracted at the summit, but not more so than in some other species of *Helichrysum*, and it does not seem necessary to transfer the species to *Leptorhynchus*.

Olearia decurrens, (DC.) Benth. Oratunga Creek, near Moolooloo (Dist. S; E. H. Ising). Almost all the leaves toothed in their upper part, those on the barren branchlets linear-cuneate and often 4-5 cm. long, the midrib prominent

below; style-branches with lanceolate papillose tips as long as the stigmatic part; anthers obtuse at base.

Siegesbeckia orientalis, L. Owienagin Gap, near Moolooloo (E. H. Ising). A remarkable instance of dwarfing, the specimen being only 3 cm. high, with a single terminal flowerhead.

**Erigeron canadensis*, L. Port Pirie (H. W. Andrew). Growing in marshy ground.

DESCRIPTION OF PLATE XXXII.

Cyperus distachyus, All. 1, a spikelet. 2, glume spread open. 3, glume and nut. 4, pistil and stamens.

Casuarina stricta, Ait. 5, two whorls of the male spike. 6, whorl of 8 male flowers, the 2 ciliate bracteoles of each flower facing outwards. 7, inner face of the stamen (*i.e.*, that which is turned towards the axis of the whorl), the bracteoles and the 2 connate perianth-segments having been broken away from the base and lifted upwards by the anther, to which they still cling in the form of a hood. 8, side view of the same stamen. 9, outer face of stamen, showing the 2 bracteoles and the back of the anther. 10, the 2 connate perianth-segments. *ax*, axis; *anth*, anther; *br*, bracteole; *per. s*, perianth-segment.

Casuarina distyla, Vent. 11, two whorls of the male spike. 12, outer face of young male flower, still enclosed in the 2 bracteoles. 13, inner face of same, showing the 2 bracteoles and the base of one of the perianth-segments. 14, male flower at a later stage, showing the 2 bracteoles and the 2 perianth-segments partially enclosing the anther. 15, the same in the final stage; the perianth-segments have fallen and only the persistant bracteoles surround the filament.

A Revision of the Australian Salicornieae.

By J. M. Black.

[Read October 9, 1919.]

Plates XXXIII. to XXXVII.

A tribe of *Chenopodiaceae*, popularly called "samphire" in Australia; low shrubs composed of imbricate articles more or less saucer-shaped at the summit and succulent during the first year. Later on the articles harden and finally lose all sign of the margins at the summit, becoming a continuous woody branch or stem. The flowers are normally arranged in 3's in hollows on each side of the lower part of the fertile articles, but in *Salicornia australis* 1 or 2 pairs of flowers are added at each side of the triad, so that we have a row of 5 or 7 flowers, instead of 3, or a whorl of 10 or 14 flowers, instead of one of 6. In *Tecticornia cinerea*, on the other hand, the triad is doubled and there are 6 flowers under each scale, or a whorl of 12 in all. The flowers are more or less protected by the margin of the article just below them. The article is usually regarded as consisting of 2 opposite rudimentary leaves, united by a sheath and combined with a succulent base which surrounds the whole internode.

In all the genera except *Tecticornia* the articles are practically of one form and there is so little difference between barren and fertile articles that in *Arthrocnemum halocnemoides* and *Pachycornia tenuis* one sometimes finds new shoots springing from the summit of the flowering spike, or the lower articles of the spike are barren. In *Tecticornia* the barren articles resemble those of other genera, but the fertile ones are split to the axis into 2 spreading opposite scales, and the stout spike consists of these scales decussately arranged along the axis.

The flowers are either bisexual or male only. In most species they are normally bisexual, but in *Arthrocnemum arbuscula* and in *Pachycornia* the central flower is bisexual and the 2 lateral are male. There is usually one stamen to each flower, and it is placed in front of the pistil. The only exceptions I have found are *Salicornia australis*, which has often 2 stamens, one before and one behind the pistil, and *Pachycornia robusta*, in one central flower of which were 2 stamens. The stamens ripen and protrude while the pistil is still very young, and this fact may easily lead to error in the examination of relaxed specimens, because the stamen is conspicuous, while the pistil is very difficult to find, and a flower

which is really bisexual may be taken for a male. Another difficulty is that the anthers fall early and even the filament sometimes disappears from the open perianth, so that the somewhat similar mistake may be made, at a later stage, of considering a bisexual flower as female only. There is, however, considerable irregularity about the sex of flowers and in some cases there appears to be a tendency for the upper flowers of the spike to be male only. Much further work is required in the examination of living specimens.

The lobes or teeth of the perianth have been described by most authors with greater fullness than in some cases they deserve. The examination of living plants shows that in *Arthrocnemum halocnemoides* and *A. arbuscula* the young perianth completely encloses the male and female organs without any perforation at the summit. Probably the texture is thinner above the stamens and style, and as these develop they push through the perianth, leaving an irregularly lacerated opening. In *Arthrocnemum Lylei*, on the other hand, each perianth is divided at the truncate summit into 3 equal deltoid lobes, and in *Pachycornia robusta* there are 3 or 4 unequal lobes. As regards other species further researches should be made in the living plant.

The articles are, in the majority of species, so much alike that they afford an uncertain means of distinguishing between them. The exceptions are *Tecticornia cinerea*, *Pachycornia robusta*, and, to a lesser extent, *P. tenuis*. The fruiting perianth, pericarp, and seed are a much surer guide, as their characters are strongly differentiated and remain constant within the species or variety. The wrinkling and granulation of the testa in the rough-seeded species seems to be due to a shortening and contraction of the cells towards the back of the seed.

The fruiting perianth is various in texture, from thin and membranous to thick and spongy. The pericarp varies still more. It may be a delicate, hyaline membrane, often difficult to find, which breaks away from the base of the perianth and remains attached to the upper part of the latter, or it may become hardened and almost horny, or it may, along with the perianth, become more or less absorbed in the enlarged and hardened rhachis *(Pachycornia)*. In *Arthrocnemum* and *Salicornia* both perianth and pericarp usually open at the base before they fall from the spike, and the seed escapes in this manner. In *Tecticornia* the perianth splits into 2 segments or valves and the seed has already escaped from the base of the delicate pericarp. In *Pachycornia* the spike doubtless falls to the ground, and sun and moisture in time split open the bony axis and release the seed.

Much confusion has been caused in this difficult tribe by the description of specimens which had only reached the flowering stage. To prevent an increase of this confusion in the future it would seem desirable that botanists should refrain from naming new species unless they are in a position to describe the fruiting perianth, the pericarp, and the ripe seed.

The first serious work in this tribe was done by Moquin in his Chenopodearum monographica enumeratio, 108-116 (1840), and later on by the same author in DC. Prodromus, xiii., ii., 144-152 (1849). Bentham dealt with the Australian species in Fl. Aust. v., 201-205 (1870), and J. D. Hooker, in Benth. et Hook. Gen. pl. iii., 65 (1883), stablished two new Australian genera:—*Pachycornia* and *Tecticornia*. Dr. Ove Paulsen determined the *Chenopodiaceae* brought from Western Australia by Dr. Ostenfeld (C. H. Ostenfeld, Contributions to West Australian Botany, part 2, Dansk Botanisk Arkiv, ii., No. 8, 56-66, ann. 1918) with several illustrations. Two monographs by Ungern-Sternberg (Versuch einer Systematik der Tribus Salicornieae, ann. 1866; Salicorniearum Synopsis in Atti del Congresso internaz. botan. in Firenze, 259-343, ann. 1876) are not accessible here.

The specimens from the localities named below have all been examined by me.

I have to thank the Government Botanists of Victoria (Prof. A. J. Ewart), N. S. Wales (Mr. J. H. Maiden), Queensland (Mr. C. T. White), and South Australia (Prof. T. G. B. Osborn) for permitting me to examine many valuable specimens from the National Herbaria.

Fertile articles slightly lobed at summit or almost entire.
- Seeds with copious albumen.
  - Fruit free and usually falling off with the perianth ... ... 1. ARTHROCNEMUM
  - Fruit embedded in the enlarged, bony axis ... ... 2. PACHYCORNIA
- Seeds without albumen ... ... 3. SALICORNIA

Fertile articles divided to the base into 2 spreading segments or scales ... ... 4. TECTICORNIA

1. ARTHROCNEMUM, Moq.

Section 1. *Trachysperma*. Pericarp membranous; seed compressed; seed-coats 2, distinct, the outer crustaceous and bearing granules arranged in more or less concentric rows, the inner coat membranous.

- Perianth spongy, without distinct lobes; pericarp hyaline, inconspicuous ... 1. *A. halocnemoides*
- Perianth herbaceous, with 3 broad lobes; pericarp hardened at summit and conspicuous ... ... 2. *A. Lylei*

Section 2. *Leiosperma.* Pericarp horny; seed compressed, the 2 coats very thin and coherent, so as to present the appearance of 1 membranous, smooth seedcoat.

Spikes and branchlets stout; flowers all bisexual ... ... 3. *A. leiostachyum*

Spikes and branchlets slender, the spikes very short; central flower bisexual, the 2 lateral male ... ... 4. *A. arbuscula*

1. **A. halocnemoides,** Nees in Pl. Preiss., i., 632, ann. 1844-5. (Pl. xxxiii.) Shrub 20-120 cm. high, branches erect or intricate, barren articles 3-5 mm. long, slender (2 mm. thick), or stouter (4-5 mm. thick), constricted at each end, both forms of article often occurring on the same plant, lobes inconspicuous; spikes terminal and lateral 10-50 mm. long, usually turning red; fertile articles 6-40, short (2 mm. long, 3-4 mm. thick); flowers in 3's, all bisexual, fruiting perianth white, spongy, dilated at summit; pericarp hyaline, at length almost disappearing; seed compressed ovate-oblong, 1-1½ mm. long, placed obliquely in the pericarp; testa crustaceous, in the typical form light brown, granular on the back, smooth in front; endopleura membranous; albumen lateral; embryo slightly curved, the cotyledons one-third as long as the radicle. —*Salicornia arbuscula*, Benth. Fl. Aust., v., 203 (1870), ex parte; *S. tenuis*, Benth., *l.c.*, 204, ex parte (*i.e.*, quod ad ea specimina pertinet, quae auctor feminea censuit).

S. Australia. Salt lands along Port Adelaide River at Ethelton and Birkenhead (J. M. B., Feb.-April, 1919): Port Pirie (H. W. Andrew, July, 1919); Nilpena (R. Helms, May, 1891, "salt soil round spring," in Tate Herb, as *S. tenuis*); N.W. interior of S. Australia (J. McD. Stuart, in Botanical Museum of Melbourne as *S. tenuis*); Murat Bay (J. M. B., November, 1915); Port Wakefield (J. M. B., November, 1919).

Victoria. Geelong (H. B. Williamson).

N. Territory. Finke River (in Phytological Museum of Melbourne as *Salicornia leiostachya*).

W. Australia. Fremantle (Preiss., Jan., 1839, No. 1910, "in turfosis aquâ marinâ subinde inundatis prope oppidulum Fremantle"); Burswood Island, near Perth (F. W. Wakefield, Jan., 1914, per D. A. Herbert); "West Australia" (Drummond, no precise locality or date, in Botanical Museum of Melbourne as *Salicornia arbuscula*).

This species was united by Benthan with *Salicornia arbuscula*, R. Br., although he gives the number of fertile articles correctly in the latter as 2 to 6, whereas Nees gives them as 8 to 12 for his species. In reality they are much more

numerous; the specimen from Burswood Island, W.A. has as many as 20, and in our South Australian coastal specimens the number of articles in the spike runs up to 30 and 40. The fruit, seed, and the number of bisexual flowers in each triad are quite different in the two species. In Nees' type specimen (Preiss, No. 1910) the seeds, although not quite ripe, show distinctly the characteristic markings of the testa.

For an explanation of what I believe is the confusion of two species in Bentham's *Salicornia tenuis* see below under *Pachycornia tenuis*.

Var. **pergranulatum,** n. var. (Tab. xxxiii.) A typo variat semine orbiculari-reniformi circiter 1 mm. diametro, testâ brunneo-rubrâ omnino subconcentrice granulatâ.

S. Australia. Salt lands near the Grange and at Birkenhead (Port Adelaide River, J. M. B., Jan.-May, 1919); Noarlunga (J. M. B., Jan., 1905); River Frome, near Marree (J. M. B., October, 1917); between Port Elliot and Victor Harbour (H. W. Andrew, Feb., 1919); Mann Crossing, River Murray (H. W. Andrew, Nov., 1915); Lake Hart (Dr. G. Taylor, May, 1919); Cootanoorinna (near Warrina, R. Helms, in Tate Herbarium as *Salicornia leiostachya*, May, 1891).

Queensland. Port Alma, C.Q. (L. Hassell, in Queensland Herbarium as *S. leiostachya*, October, 1917).

The variety differs from the type in its seed, which is orbicular-reniform, reddish-brown and granular all over. It is usually a lower shrub, more spreading, and 30-50 cm. high. In the specimens from Frome River and Port Alma the position of the pericarp in the perianth is almost horizontal, instead of oblique, and although some of the seeds are ripe, the perianths have not separated from the article, and the membranous pericarp adheres more or less to the seed. The greater or lesser obliquity of the fruit does not seem to be of much importance, for in the Cootanoorinna specimen the pericarp is horizontal, but the perianths are falling from the spike. The seeds bear considerable resemblance to those of *Silene*, *Calandrinia*, and *Mesembryanthemum*.

2. A. Lylei, (Ewart et White) combin. nov. (Tab. xxxiv.) Haec species distat ab *A. halocnemoidi* pericarpio mamilliformi apice crustaceo horizontaliter prominente atque perianthio distincte et late trilobo herbaceo non spongioso.—*Salicornia Lylei*, Ewart et White in Jour. Roy. Soc., N.S. Wales, xlii., 195, t. 34 (1908).

A very distinct species by reason of its ovoid pericarp, which is membranous except near the summit, where it becomes crustaceous and is produced in a nipple-like point (the persistant style) beyond the 3 broad lobes of the perianth;

perianth herbaceous and somewhat fleshy, dilated and truncate at the summit, protruding conspicuously beyond the fertile articles and finally adherent to the base of the pericarp; barren articles 3-5 mm. long, 2 mm. thick, the lobes rather acute and keeled; spikes 8-22 mm. long, terminating short, opposite branches; fertile articles 5-15, 2 mm. long, 3 mm. thick; flowers in 3's, all bisexual, but (at least in the specimens examined) very few of them ripening fruit; seed compressed, ovate, 1½ mm. long; testa reddish-brown, granular on the back, smooth in front; endopleura membranous; albumen lateral; embryo slightly curved, the cotyledons one-third as long as the radicle.

W. Australia. Cowcowing, near salt lakes (type collected by Max Koch, Sept., 1904, No. 1051); Lake Lefroy (R. Helms, Nov., 1891, "1-3 feet high, in sand on margin of lake," in the Tate Herb. as *Salicornia bidens).*

3. **A. leiostachyum,** (Benth.) Paulsen in Dansk Bot. Ark. (1918), ii., No. 8, 61, fig. 24 et tab. 5, fig. 2. (Pl. xxxv.) Erect shrub, 40-100 cm. high, branchlets and flowering spikes dark green and stouter than in other species; barren articles 5-8 mm. long, 4-7 mm. thick, very shortly 2-lobed and usually ciliolate on the margin, dilated and keeled below the lobes; spikes 10-30 mm. long, terminal and lateral; fertile articles 6-16, very short (2-3 mm. long) 4-7 mm. thick, in fruit brown and overlapping closely, so as to make the spike appear almost continuous; flowers in 3's, all bisexual; fruiting perianth spongy or fleshy, dilated at summit, adherent to pericarp, which is horny, ovate-oblong and tapering towards summit; seed slightly compressed, obovate, smooth, whitish, 1-1½ mm. long; seedcoats coherent; embryo sometimes almost straight, not reaching the summit of the seed, so that the albumen is terminal as well as lateral; cotyledons one-third, or sometimes nearly as long as rudicle.—*Salicornia leiostachya*, Benth. Fl. Aust., v., 203 (1870). *A. Benthami*, Paulsen, *l.c.*, 62, fig. 24 et tab. 6, fig. 2 (judging from the description and the identification of a specimen collected at Port Adelaide by J. G. O. Tepper and seen by Paulsen in the Berlin Herbarium).

S. Australia. Port Adelaide River (Prof. T. G. B. Osborn, October, 1912); salt and rather swampy land behind sand dunes at the Grange, near Adelaide (J. M. B., Jan.-April, 1919); Mulgundawa, near Lake Alexandrina (J. M. B., October, 1906); Marree (J. M. B., October, 1917); Elder Expedition, May 25 (in Tate Herb. as *S. leiostachya*: no locality given, but the expedition was, on May 25, 1891, at Arcoellinna Well, at the head of the Arkaringa Creek).

N. Territory. Finke River (H. Kempe, 1881; in National Herb. of Victoria as *S. leiostachya);* 10 miles west-south-west

of Stuart Range (G. F. Hill, June, 1911; in National Herb. of Victoria as *S. leiostachya);* between Crown Point and Horseshoe Bend, Finke River (S. A. White, Aug. 1913).

W. Australia. No locality (Drummond, in National Herb. of Victoria as *S. leiostachya).* This is one of Drummond's specimens, on the strength of which Bentham included Western Australia *(l.c.* 204). It strongly resembles the eastern specimens, but it has no fruit.

The coastal form is a stouter plant with thicker articles than those of the form found in the interior of the continent.

4. **A. arbuscula,** (R. Br.) Moq. Chenop. enum., 113, ann. 1840. (Pl. xxxv.) Shrub 30-80 cm high; branches often erect and rather slender; barren articles dark green, 3-4 mm. thick, contracted at summit, lobes obtuse and inconspicuous; spikes terminal and lateral, 6-10 mm. long, often reddish and spreading; fertile articles 2-6, 3-4 mm. thick, almost globular (with the exception of the obconical part concealed in the inferior article); flowers in 3's, the central one bisexual, the 2 lateral male; perianth at first membranous, afterwards rather fleshy and adherent to pericarp, contracted towards summit, persistant; fruit rather erect, triangular in outline, the style protruding beyond the perianth; pericarp horny; seed slightly compressed, obovoid, 1½-2 mm. long, smooth, straw coloured; seedcoats membranous, coherent; embryo reaching summit of seed; albumen lateral; cotyledons half as long as the radicle.—*Salicornia arbuscula,* R. Br., Prodr., 411 (1810).

S. Australia. Salt ground along Port Adelaide River at Ethelton (J. M. B., October, 1918, April, 1919); on mud beside Port River near the Grange (Prof. T. G. B. Osborn, October, 1918); Cootanoorinna, a few miles west of Warrina (R. Helms., May, 1891; in Tate Herb. as *S. arbuscula); Port* Noarlunga (J. M. B., Jan., 1905); Murat Bay, J. M. B., Nov., 1915).

Victoria. Point Lonsdale (ann. 1867; in National Herb. of N.S. Wales as *S. arbuscula);* Wimmera (Dallachy; in National Herb. of Victoria as *S. arbuscula).*

Tasmania. I have seen a specimen from W. H. Archer's Herb. of Tasmanian plants, in the National Herb. of N.S. Wales, without locality or date.

I have here treated the East-Australian specimens as the typical *S. arbuscula.* Brown gives "M D" as his localities, "M" being the south coast from Cape Leeuwin to Wilson Promontory, and "D" Van Diemen Land (Tasmania). Of the Western Australian specimens quoted by Bentham I have only examined one of Drummond's from Swan River, which

was seen by Bentham and is now in the National Herb. of Victoria. This appears to me to be specifically distinct from the eastern specimens and to belong to *A. halocnemoides*. It was probably from this source that Bentham drew his statement that all the flowers are bisexual. This is not true of *A. arbuscula*, where, if 2 pistils are found in the triad, it is quite an abnormal occurrence. The only specimens mentioned by Bentham as having been collected by Brown are those from Port Dalrymple, Tasmania, and the Tasmanian plant is the one here described and figured as *A. arbuscula*.

A. (?) *pruinosum*, Paulsen, *l.c.* 63, from Carnarvon, W. Aust., is described without fruit. The spike has 8-17 articles, and judging by the photograph, plate vi., fig. 3, it is *A. halocnemoides*.

A. brachystachyum, Paulsen, *l.c.* 64, fig. 26; tab. vi., fig. 4, is described as having 4-8 fertile articles, perianth exserted, pericarp brown and hard; seedcoat not mentioned. Also from Carnarvon, W. Aust., and possibly a poor specimen of *A. leiostachyum*.

A. bidens, Nees in Pl. Preiss., i., 632 (1844-5). I have not been able to come to any decision with regard to this species. Nees described it from a specimen without fruits collected on the banks of the Swan River. A cotype (Preiss, No. 1261) lent me from the National Herb. of Victoria, is figured on plate xxxiv. of this volume, in the hope that this may be of some assistance to future investigators. It is in such early flower that it is only possible to say that the flowers are arranged in 3's and apparently all bisexual. I have also seen another of the specimens quoted by Bentham below his description of the plant as *Salicornia bidens* (Fl. Aust., v., 204)—"margin of salt lakes, north of Stirling Range, F. Mueller, October, 1867." This specimen has rather stout branches and no unusual lobing of the barren or fertile spikes. It has one imperfect (broken) spike 40 mm. long, with 13 articles, and 2 or 3 shorter lateral spikes. All perianths and fruit have fallen from the spike. There is nothing to prove that it belongs to the same species as the Swan River specimen, or that it is not a *A. halocnemoides*. Bentham's description, *l.c.*, of some fruiting specimen which he believed to be *S. bidens*, agrees very well with *A. halocnemoides* as regards perianth and fruit. That species, it may be mentioned, sometimes shows in its lower barren articles (but not in the fertile ones) a close approximation to *A. bidens*. It seems impossible to make any further progress until some botanist re-discovers this acute-lobed plant on the banks of the Swan River and then traces it to the fruiting stage.

2. Pachycornia, Hook.f.

Branches stout; articles long-lobed; embryo almost annular	1. *P. robusta*
Branches slender; articles short-lobed; embryo almost straight	2. *P. tenuis*

1. **P. robusta,** (F. v. M.) Hook. f. in Benth. et Hook, Gen. pl. iii., 65, ann. 1883. (Plate xxxvi.) A low shrub with robust branches; sterile and fertile articles with 2 prominent, acute, spreading lobes, distinctly keeled, about 10 mm. broad at summit, the sterile ones 10-20 mm. long, the fertile ones only about 5 mm. long; spikes short and thick (10-20 mm. long), usually terminating short, opposite branches, with 4-6 articles; flowers in 3's, the central bisexual, the 2 lateral male; perianth membranous, irregularly 2-4 lobed at summit, where it is slightly contracted; pericarp soon hardening and becoming adherent to the enlarged bony axis of the spike; seed often solitary in the article, orbicular-reniform, slightly compressed, more or less completely inverted; seedcoat one, subchartaceous, reticulate; albumen central, because the embryo is almost annular; cotyledons and radicle both curved upwards, the former rather longer than the radicle.

S. Australia. Chowilla, River Murray (Jan., 1884, in Tate Herb.); Renmark (J.M. B., October, 1915).

Victoria. Mildura (H. B. Williamson).

N.S. Wales. Lake Victoria (S. A. White, Sept., 1917).

N. Territory. Alice Creek (Horn Expedition, in Tate Herb.)

2. **P. tenuis,** (Benth.) combin. nov. (Tab. xxxvi.) Fruiticulus erectus, ramis ramulisque tenuibus, sterilibus articulis 5-15 mm. longis 2-3 mm. crassis, lobis late scarioso-marginatis obtusis vel acuminatis, spicis 8-16 mm. longis ramulos oppositos terminantibus, fertilibus articulis 4-6, fructiferis subglobosis 4-5 mm. longis, floribus ternis articulo inferiore occultis, centrali bisexuali, duobus lateralibus masculis, perianthio membranaceo, pericarpio primum corneo deinde cum spicae rhachi auctâ et osseâ conjuncto, semine subcylindrico 4 mm. longo basin versus attenuato in cavo rhacheos induratae recondito (saepius per quadrantem ambitus cavi ita se circumagente ut unum semen alteri non tergo sed latere adjaceat), integumento uno membranaceo laevi albido, albumine laterali, embryone levissime curvo, cotyledonibus radiculae aequilongis.—*Salicornia tenuis*, Benth. Fl. Aust., v., 204 (1870) ex parte (quantum ad specimina quae auctor mascula existimavit); *S. Donaldsoni*, Ewart et White in Journ. Roy. Soc. N.S. Wales, xlii., 194, t. 33 (1908).

S. Australia. Without date or locality but probably near Cooper Creek (Howitt Expedition, 1861-2, in National Herb. of Victoria); Mt. Parry, between Lake Torrens and Leigh Creek (R. Tate, Sept., 1883, in Tate Herb.); Marree (J. M. B., October, 1917).

N. Territory. Henbury Station, Finke River (G. F. Hill, March, 1911, in National Herb. of Victoria as *Salicornia cinerea).*

Queensland. Georgina River (E. W. Bick, Sept., 1910, in Queensland Herb. as *Tecticornia cinerea).*

W. Australia. Lake Cowcowing (Max Koch, No. 1147, Sept., 1904, in National Herb. of Victoria as *Salicornia Donaldsoni).*

The Howitt specimen is one of those on which Bentham founded his *Salicornia tenuis*, conceiving them to be the male plant of a dioecious species. He says:—"The specimens are very few and I do not feel certain that the male and the fruiting ones are correctly matched." He was doubtless misled by the fact that Howitt's specimens are in early flower, at which stage, owing to the proterandrous character of the tribe, the stamens are much more conspicuous than the pistils. In the type specimen placed at my disposal by Professor Ewart I was able to find pistils with the characteristic hardening of the young pericarp in some of the central flowers. Usually it is possible to distinguish the species, even without flowers, by the conspicuous scarious margins of the barren articles. In the long, almost straight and cylindrical seed, tapering at the base, it differs from any other species in the tribe with which I am acquainted. During the hardening of the pericarp and rhachis of the spike the seed appears to revolve on its own axis to the extent of one-quarter of the circumference of the cavity, so that, where there are two seeds in the article, they lie side by side (as shown in pl. xxxvi., fig. 11), instead of in the normal position of back to back. To ascertain whether this change is constant would require the examination of more material than was to hand. Sometimes, through abortion, only one seed remains in the ripe article; this is also true of *P. robusta.*

J. McDouall Stuart's specimens from the "north-west interior of South Australia," which Bentham accepted as the female plant of *S. tenuis*, are in fruit, and certainly belong to the species here described and figured as *Arthrocnemum halocnemoides*, Nees. As the branches of *P. tenuis* are the more slender of the two, it seems the proper one to bear Bentham's specific name. Judging from the localities quoted by Bentham, both species occur in the Darling district of N.S. Wales.

3. Salicornia, L.

1. **S. australis,** Banks et Sol. (MSS. et ic.) ex Hook. f. Fl. N. Zel., i., 216, ann. 1853 (nomen pro synonymo *S. indicae,* Willd. perperam citatum, sed cum descriptione *S. australis*); Sol. ex Forster f. Prodr. 88, ann 1786 (nomen nudum fide Benth. Fl. Aust., v., 205, ann. 1870); *S. quinqueflora,* Bunge ex Ung.-Sternb. Vers. Syst. Salic., 59, ann. 1866. (Pl. xxxvii.) Low shrub with procumbent stems rooting at the nodes; branches usually erect, light green; barren articles 7-20 mm. long, 3-5 mm. thick, lobes short but acute, keeled; spike 10-45 mm. long, when ripe 4-7 mm. thick and often bright red; fertile articles 5-20, subglobular; flowers in 5's or 7's, rarely in 3's near summit of spike, all bisexual; stamens 1 or 2; perianth at first membranous, afterwards thickened and rather hard, dilated and truncate at summit; pericarp hyaline; seed suborbicular, compressed, 1½ mm. diam.; testa chartaceous, straw-coloured, softly villous; endopleura membranous, enclosing separately the cotyledons and the radicle, which are of equal length and folded on one another; albumen absent.

At Port Victoria the plant grows in low, cushion-like tufts and has a strong tendency towards dioecism, the spikes in one tuft having flowers with 2 stamens, and a pistil (perhaps abortive) with very short style-branches; the spikes of another tuft have pistils with long style-branches and no apparent stamens.

S. Australia. In salt soil at Patawalonga Creek, near Glenelg; Port Adelaide River at Ethelton, Birkenhead, and the Grange; Port Elliot; Port Noarlunga; Lake Ormerod, near Naracoorte; Murat Bay; Mount Nor' West (between Lake Torrens and Lake Eyre); Port Victoria, Y.P.

Queensland. Cabbage-tree Creek, Moreton Bay; Mooloolah River (C. T. White, in Queensland Herb.).

This species, easily recognizable by the unusual number of flowers below each fertile article, appears to inhabit all the Australian States and also New Zealand.

Banks and Solander's MSS. and illustration of this species, mentioned by Hooker, as above, have not been reproduced by J. Britten in Illustrations of the botany of Captain Cook's voyage (1900-05).

Halocnemum australasicum, Moq. Chenop. enum. 110 (1840), from King George Sound, was left undecided by Bentham (Fl. Aust., v., 202 and 205), who had not seen the specimen. In Benth. et Hook. Gen. pl. iii., 65, it is stated to be *Salicornia quinqueflora,* Bunge (= *S. australis*). If it is really that species it is strange that Moquin should have placed it in *Halocnemum,* a genus which he describes as possessing "albumen basilare et laterale, parcum, carnosum."

TECTICORNIA, Hook. f.

1. **T. cinerea,** (F. v. M.) Hook. f. in Benth et Hook, Gen. pl. iii., 65, ann. 1883. (Pl. xxxvii.) A low plant, of which I have only seen one rooted specimen (from Darwin). This has procumbent, woody stems and erect or ascending branches 4-8 cm. long. Bentham says "apparently annual," but it seems rather to be perennial, like other species within the tribe. Barren articles 5-10 mm. long, 3-4 mm. thick at the summit, which is dilated and rather acutely lobed, the scarious margin prominent; spikes usually terminal and solitary 10 to 25 mm. long, 6 to 8 mm. thick, obtuse; fertile articles 15-30, each article divided to the axis and thus transformed into 2 scarious spreading scales, the outer margin of which is thickened and herbaceous below, scarious above, and flattened vertically (*i.e.* at right angles to the scale), so that the scarious portion shelters the flowers of the scale next above it; flowers in 6's (not in 3's, as stated by Bentham), usually bisexual, horizontal, at first attached to the lower face of the scale, afterwards free; perianth finely membranous, compressed, contracted towards summit, usually 2-lobed and separating into 2 segments; pericarp hyaline and quickly seceding from the base of the perianth; seed compressed-ovate, 1½ mm. long, much resembling that of *Arthrocnemum halocnemoides*, but the granules or papillae along the centre of the back are rather longer, sometimes almost hair-like; testa light-brown, crustaceous; endopleura membranous; albumen lateral; cotyledons nearly as long as radicle.—*Halocnemum cinereum*, F. v. M. Fragm., i., 140 (1859); *Salicornia cinerea*, F. v. M. Fragm., vi., 251 (1868); Benth. Fl. Aust., v., 203 (1870).

N. Territory. Sturt Creek (the type; collected by F. v. Mueller, when accompanying A. C. Gregory's Expedition in 1856). Sturt Creek lies principally in Western Australia, so that it is very probable the specimen was gathered there, but Mueller does not quote that State for the species in his 2nd Census. Darwin (M. Holtze, 1883, from National Herb. of Victoria).

Queensland. Townsville (Rev. N. Michael, June, 1918); Archer River (Rev. N. Hay; both in Queensland Herb.).

DESCRIPTION OF PLATES.

PLATE XXXIII.

Arthrocnemum halocnemoides, Nees. The central figure shows fruiting spikes. 6, 3 fruiting perianths, seen from above, 2 containing seeds (Finke River). 7, seed (Drummond's Western Australian specimen). 8, embryo. 9, perianth with seed protruding (J. McDouall Stuart's specimen). 10, seed (the same). 11, pistil and stamen (Birkenhead).

Var. *pergranulatum*, n. var. The central figure shows flowering spikes. 1, vertical section of an article in fruit (Grange). 2, fruiting perianth and seed (Lake Hart). 3, the same (Cootanoorinna). 4, transverse section of perianth and fruit (Cootanoorina). 5, seed (Grange).

Abbreviations for all plates: *a*, article; *alb*, albumen; *anth*, anther; *ax*, axis; *cot*, cotyledons; *e*, embryo; *epl*, endopleura; *fil*, filament; *p*, perianth; *pc*, pericarp; *ps*, pistil; *rad*, radicle; *t*, testa.

Plate XXXIV.

Arthrocnemum Lylei, (Ewart et White) comb. nov. Central figure a fruiting spike. 1, 3 perianths seen from the front. 2, central perianth and pericarp. 3, pistil and stamen. 4, seed (all from the type, Cowcowing, except No. 4, which is from Lake Lefroy).

A. bidens, Nees. A flowering spike and part of the branch (from the type, Swan River).

Plate XXXV.

Arthrocnemum arbuscullа, (R. Br.) Moq. Central figure a flowering branch. 1, transverse section of a flowering article. 2, flowering article from the front. 3, pistils (all from Ethelton). 4, pericarp (fruit). 5, vertical section of seed (both from Noarlunga). 6, fruiting article, from the side (Tasmania). 7, transverse section of fruiting article (Ethelton).

A. leiostachyum, (Benth.) Paulsen. Central figure flowering branch (from the Grange). 8, 3 fruiting articles, the lowest one showing the cavity from which 3 fruiting perianths have been taken (Grange). 9, vertical section of fruiting perianth (Port Adelaide River). 10, seed (Finke River). 11, transverse section of fruiting perianth (Stuart Range). 12, vertical section of seed (Stuart Range).

Plate XXXVI.

Pachycornia robusta, (F. v. M.) Hook. f. 1, 3 perianths after the anthers have fallen. 2, vertical section of pistil with ovule somewhat advanced. 3, transverse section of fruiting article. 4, seed. 5, vertical section of seed.

P. tenuis, (Benth.) comb. nov. 6, flowering branch (Howitt Expedition). 7, fruiting spike (Georgina River). 8, 3 perianths (Mount Parry). 9, pericarp and young seed (Mount Parry and Cowcowing). 10, fruiting article (Marree). 11, transverse section of fruiting article and axis (Marree and Georgina River). 12, vertical section of fruiting article and axis, showing 2 cavities from which seeds have been removed (same localities). 13, vertical section of seed (same localities and Mount Parry).

Plate XXXVII.

Tecticornia cinerea, (F. v. M.) Hook. f. Central figure represents a flowering and a fruiting spike. 1, transverse section of spike, showing 4 scales, 2 of them supporting flowers in an advanced stage. 2, fruiting perianth spread open and fruit. 3, flowering perianth. 4, seed (all from Townsville and Darwin specimens).

Salicornia australis, Banks et Sol. 5, flowering perianth. 6, pistil and 2 stamens. 7, seed. 8, vertical section of seed. 9, transverse section of seed.

Notes on Three Species of Melaleuca

By Edwin Cheel, Botanical Assistant, Botanic Gardens, Sydney.

(Communicated by J. M. Black.)

[Read October 9, 1919.]

Plate XXXVIII.

Meluleuca pustulata, Hook. f., in Hook. Lond. Jour. Bot., vi., 476 (1847). The original description is as follows:—

"Ramis glabris albo-striatis, ramulis puberulis, foliis glaucis alternis subapproximatis erecto-patentibus subrecurvis crassis glaberrimis lineari-obovatis anguste linearibusve obtusis supra planis subter concavis punctato-tuberculatis, capitulis flavis terminalibus sessilibus plurifloris sphaericis, hypanthio breviter villoso, calycibus glaberrimis, lobis subherbaceis, phalangibus staminum 5.

"Hab. Campbell Town and Oyster Bay: *Gunn.*

"Rami graciles, lineis e basi petiolorum continuis albidis striati, ramulis puberulis. Folia $\frac{1}{4}$-$\frac{1}{3}$ unc. longa, sub 1 lin. lata, in petiolum brevem angustata. Capitula vix $\frac{1}{2}$ unc. diam. Flores parvi."

Then we have a further description in Hooker's Fl. Tasm., i., 129 (1860).

Bentham (Fl. Aust., iii., 160, ann. 1866) quotes both the above works and gives a lengthy description, with *M. halmaturorum*, F. v. M., adduced as a synonym, but as the latter is a South Australian plant, and has distinctly opposite leaves, and not alternate, as in *M. pustulata*, it would seem to me to belong to subseries i., *Oppositifoliae*, having affinities with *M. cymbifolia* and *M. cuticularis* rather than with *M. pustulata*, which is in subseries v., *Pauciflorae*, all of which species have apparently alternate leaves.

In the National Herbarium, Sydney, we have the type specimen from the east coast of Tasmania, namely, R. C. Gunn's No. 1069. There is also a specimen from Tasmania without specific locality mentioned, collected by W. H. Archer, which was identical with Gunn's specimen. A specimen labelled "Darling River, New South Wales," without the collector's name or date, seems to very closely resemble the Tasmanian specimens, but we require further fresh material

to definitely decide if the New South Wales plants are identical with those from Tasmania. Bentham also quotes Wimmera, Victoria, as a locality for this species, which he says "has much shorter stamens," but as I have not seen the Victorian specimens I cannot say if they belong to *M. pustulata*, Hook. f., or the next species *(M. halmaturorum)*. In *M. pustulata* the young branchlets are pubescent and the leaves alternate, while in *M. halmaturorum* the branchlets are glabrous and the leaves opposite.

Melaleuca halmaturorum, F. v. M., et Miq., in Ned. Kruidk. Arch., iv., 122 (1856). The following is a copy of the original description:—

"*Melaleuca halmaturorum*, Ferd. Müll., MSS. Foliis oppositis densis hinc nunc subquaternis patule erectis subimbricatis linearibus antice planis, acutis vel obtusiusculis, non mucronatis, $1\frac{1}{2}$-2 lin. longis, $\frac{1}{4}$-$\frac{1}{3}$ latis enerviis, glaucis, glabris, petiolis adpressis, bracteis spicarum ovatis acutiusculis tubum calycis aequantibus; capsulis calycis tubo ovoideo-truncato connatis trilocularibus.

"Ad flumen Three - Wells River insulae Halmaturorum (H. Heuzenroeder). In vere.

"Habitus *M. curvifoliae*, differt foliorum situ, usque obtusiusculis, nigro-punctatis, glabritie fere perfectâ, fructibus apice minus contractis companulato - hemisphaericis, floribusque plerumque magis dissitis solitariis vel spicam paucifloram ramo altius insertam constituentibus.

"Var. β *enervis (M. enervis*, F. Müll., Herb.), foliis saepe impunctatis, floribus in capitulum collectis. In Nova Holl. australi passim. Boston-point, arbuscula (F. Müller).

"Var. γ *tuberculifera (M. tuberculifera*, F. Müll., Herb.), foliis ramorum majoribus fere semipollicaribus, $\frac{2}{3}$ lin. latis, acutiusculis vel obtusis. In Nova Holl. australi ad Gmina-bay Holdfast-bay raro (F. Müll.)."

It will be seen from Mueller's description that he had three forms or varities under review, *viz.*, *M. halmaturorum*, from Three Wells River, on Kangaroo Island; var. *enervis*, from Boston Point, near Port Lincoln; and var. *tuberculifera*, from "Gmina" Bay and Holdfast Bay. Through the kindness of Professor Ewart I have examined specimens of the original plant, which are labelled as follows:—"*M. halmaturorum*, F. v. M. Ex insulâ. Halmaturorum ad fl., 3 wells-river. H. Heuzenroeder, November, 1849."

[I would suggest that the "Gmina Bay" mentioned above is a misprint for "Guichen Bay." The plant in question grows at Robe, and Mueller collected in this district during

his residence in South Australia. The description was published in a Dutch periodical (the "Nederlandsch kruidkundig Archief"), and doubtless Mueller had no opportunity of reading a proof.—J. M. B.]

More recent records for *M. halmaturorum* are:—

South Australia.—In salt land on banks of Patawalonga River (J. M. Black, No. 1, March, 1904); numerous in salt swamps along Military Road, north of the Grange (J. M. Black, January, 1919)—at both these places the trees often reach a height of 7 or 8 m., and have a whitish bark which peels off in strips; Outer Harbour (J. M. Black, January, 1911), often a small shrub 2-4 m. high; Port Elliston (Dr. R. S. Rogers, September, 1907), recorded in Trans. Roy. Soc. S. Austr., xxxii., 264 (1908), as *M. pustulata;* Robe (C. D. Black, No. 2, October, 1910); Mount Barker, J. Staer, March, 1911); Beachport (J. M. Black, No. 3, December, 1917, near brackish water or on it, papery bark, 2-3 m. high); Port Lincoln (H. Griffith, October, 1909); Victor Harbour, at mouth of River Hindmarsh (J. M. Black, September, 1907).

Victoria.—St. Eloy (D'Alton, 1903); Lake Charm, North-west Victoria (C. Walter, March, 1887); Dimboola (H. B. Williamson, June, 1913).

M. halmaturorum is figured on pl. xxxviii., accompanying this paper. It is commonly known in South Australia as a "paper bark tea-tree," and varies in size from a small shrub to a tree of moderate height.

Melaleuca pauperiflora, F. v. M. The original description given by Mueller (Fragm., iii., 116 [1863]) is as follows:—

"Fruticosa, foliis breviusculis alternis semiteretibus vel teretinsculis acutis muticis petiolatis, capitulis multifloris, bracteis subovatus trinerviis margine membranaceis, calycis lobis enerviis antice rotundatis tubo glabro, phalangibus albidis 9-12-andris glabris profunde filamentosis, stigmate minuto, fructibus subglobosis.—In montibus Phillips Range, Maxwell."

It is also described by Bentham in Fl. Aust., iii., 161 (1866).

Diels and Pritzel, in Engl. Bot. Jahrb., xxxv., 425 (1905), refer to this species, and quote as localities in Western Australia: Wyola, Southern Cross, Bullabulling, Coolgardie. They also note its close affinity to *M. Sheathiana*, W. V. Fitzg.

In the National Herbarium, Sydney, there are a large series of specimens which, although somewhat variable as to leaf-characters, seem to be mere forms of the one species. They are as follows:—

Western Australia.—Drummond, fifth collection (No. 154), 1849. This specimen is from the British Museum, and is quoted by Bentham, *l.c.* Then we have specimens almost identical with Drummond's No. 154 from Coolgardie, collected by Dr. C. Webster in 1900; and from Camp 64, collected by R. Helms in September, 1891 (No. 15), during the Elder Expedition. A series of specimens with the leaves not quite so acute at the apex, and slightly shorter than the above, are from the following localities:—Nine miles north of Bullabulling (W. V. Fitzgerald, November, 1903), diffuse, 10 feet high; Camp 66 (R. Helms, Elder Expedition, September, 1891); 108 miles east of Kalgoorlie, in a somewhat dry swamp (6-8 feet), collected by H. Deane in July, 1909, on the Transcontinental Railway Survey; Southern Cross (J. H. Maiden, November, 1909); Israelite Bay, J. P. Brooks, September, 1915.

South Australia.—Ardrossan (J. G. O. Tepper, October, 1879, labelled "*M. ericifolia*, var. *pustulata*"); Murat, Denial, and Fowler Bays (Dr. R. S. Rogers, September, 1907); between Iron Knob and Franklin Harbour, E.P. (J. Sincock, per J. M. Black (No. 5), October, 1912); Minnipa, E.P. (J. M. Black (No. 4), November, 1915); Dublin Scrub (H. Griffith, September, 1907); a few miles north of Murat Bay (J. M. Black, November, 1915); margin of saltlake flats, Ooldea to Port Augusta (H. Deane, July, 1909); Walebing Swamp, near Kingoonya (Dr. G. Taylor, May, 1919, communicated by J. M. Black, No. 2). See also J. M. Black, in Trans. Roy. Soc. S. Austr., xlii., 49 (1918), where the species is figured on plate v.

M. Sheathiana, W. V. Fitzg., is desribed in Jour. Proc. Mueller Bot. Soc., i., (No. 9) p. 16 (1902), with the localities Lakeside and Black Flag, W.A. The type specimens are in the National Herbarium, Sydney, and a note in Mr. Fitzgerald's handwriting is as follows:—"After an examination of numerous specimens of *M. pauperiflora*, F. v. M., including the type, I am convinced that *M. Sheathiana* cannot be maintained as a distinct species."

I have carefully examined the type specimens, and have compared them with Drummond's No. 154 of *M. pauperiflora*, which is quoted by Bentham, and it seems to me that the extreme forms are so distinct that it may be advisable to regard the Lakeside and Black Flag specimens as a variety

of *pauperiflora*, and to add thereto some of the other specimens from Western Australia and South Australia, when we are able to make field observations on the various forms.

It will be seen from the above that the only specimens which come under Bentham's notice are the original ones given by Mueller, *l.c.*, and those collected by Drummond. In the series of specimens now brought under review we find that the species has a very wide range, and as a consequence it is only natural that environmental conditions will cause variation.

I am indebted to Mr. J. M. Black for several notes and for the drawings on pl. xxxviii.

DESCRIPTION OF PLATE XXXVIII.

Melaleuca halmaturorum, F. v. M. 1, flower. 2, petal, 3, leaf. 4, cluster of fruits. 5, vertical section of fruit. 6, transverse section of fruit. 7, 3-celled capsule. 8, An old tree, between 7 and 8 m. high, growing beside the Patawalonga Creek, near Glenelg.

The Cambrian Trilobites of Australia and Tasmania.

By R. Etheridge, Jun., Director and Curator of the Australian Museum, Sydney.

[Read October 9, 1919.]

Plates XXXIX. and XL.

I. Introduction.

The present communication is an attempt to condense our previous knowledge of the above group of organisms, and to suggest certain changes in nomenclature, as a basis for sounder elaboration by those who may come after and, with access to more complete and extensive material, engage in this interesting study.

The great drawback to a satisfactory elucidation of our Cambrian Trilobites lies in the imperfection of their remains as presented to us, seldom more than portion of a cephalon or pygidium, oftener simply fragments. Omitting the minute form *Agnostus elkedraensis*, I know of only one instance where the all-but complete body is preserved, that later described as *Ptychoparia alroiensis*.

The terms Lower and Upper Cambrian have been used by some in speaking of the rocks containing these old Crustaceans. I have not adopted these divisions in pages that follow, believing we know too little as yet of the Cambrian strata throughout Australia and Tasmania to warrant the use of stratigraphical subdivisions employed either in Europe or America. On the other hand, sufficient facts have already accumulated to justify the use of the term Cambrian simply for a vast thickness of beds, in all probability synchronal with those so termed in other parts of the world; in this sense it is here used. When it becomes possible to stratigraphically synchronize our oldest fossiliferous deposits, it will be more satisfactory to apply local group names, in other words, a sequence based on local facts and conditions. Two operations will accelerate this, detailed field work and energetic collecting.

With the view of recording the opinions of others, I have in each instance quoted the horizon assigned to a given species.

II. History.

1877.—So far as my researches have progressed, the first geologist to discover Trilobite remains in Australia, afterwards

shown to be of Cambrian age, was Mr. Otto Tepper.[1] We only know the bare fact that a Trilobite was found by him in the Parara Limestone, south of Parara Station. The exact horizon of this fossil was not made very clear, unless it occurred in the "variegated and dark-coloured limestone," or "white and yellow marbles."

1880.—The next in the field appears to have been our old friend Prof. Ralph Tate,[2] who exhibited at a meeting of the Royal Society of South Australia, held on November 1, 1879, "a well-preserved head of a trilobite, which showed no traces of eyes," from the "Lower Silurian" of Ardrossan, Yorke Peninsula. It would be interesting to know if this was one of the specimens afterwards described by Tate in 1892.

1882.—In this year appeared a reference,[3] probably by Prof. Tate, to the "head of a Trilobite" from Ardrossan, "apparently of the same species as previously found, but of a very much larger size. . . . The glabella is an inch and a quarter long and three-quarters wide, with three pairs of oblique furrows; its surface is ornamented with numerous close-set granules." It would also be interesting to ascertain the whereabouts of this specimen.

1882.—In this year there appeared the announcement of the occurrence of Cambrian Trilobites in Tasmania by myself, through specimens sent to me by Mr. Thomas Stephens, M.A., formerly Chief Inspector of Schools of that State. These were obtained from a decomposed ferruginous sandstone at Caroline Creek, near Latrobe,[4] and consisted for the most part of fragments beyond determination. But amongst these was a cephalon described as *Conocephalites stephensi*, and a pygidium as *Dikelocephalus tasmaniensis*. With these were some interesting glabellae that I was, and still am, quite unable to satisfactorily refer to any genus within my knowledge.

This Caroline Creek sandstone was termed by Mr. R. M. Johnston[5] the "Dikelocephalus Group" in his system of classification of Tasmanian rocks. He also stated that the first observer to draw attention to these fossils was Mr. Charles Gould in 1862, the then Government Geologist. By Mr. L.

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[1] Tepper: "Introduction to the Cliffs and Rocks at Ardrossan," Trans. Phil. Soc. Adelaide, 1877-78 (1878), p. 77.

[2] Tate: Trans. Roy. Soc. S. Austr., iii., 1880, p. xiv.

[3] Anon.: Trans. Roy. Soc. S. Austr., iv., 1882, p. 145.

[4] Etheridge: Papers and Proc. Roy. Soc. Tas., 1882-83 (1883), p. 155.

[5] Johnston: Syst. Acc. Geol. Tas., 1888, p. 33.

K. Ward the Caroline Creek beds are said to "have been definitely referred to the Upper Cambrian."(6)

1884.—Dr. Henry Woodward described(7) two imperfect cephalons from the Parara Limestone as *Dolichometopus tatei* and *Conocephalites australis;* he ascribed to them a Lower Silurian age. A re-examination of these specimens is necessary before it is practicable to say what they may be.

1888.—During this year I received from Mr. W. Howchin an Ardrossan cephalon, which I referred to *Ptychoparia* as *P. howchini.*(8)

1890.—The first Cambrian fossils collected in North-western Australia were obtained by Mr. E. T. Hardman,(9) but for many years the exact source of these fossils was in doubt. This uncertainty has now been satisfactorily set at rest by a very careful and painstaken analysis of Hardman's reports and maps by Mr. L. Glauert,(10) whose determinations are here adopted.

Hardman's fossils from the Ord River were first critically examined by myself at the British Museum in 1885, when I attached MS. names to several I intended to describe. Circumstances prevented this, but Mr. A. S. Foord(11) took up the work, and honoured me by adopting my MS. names. One, a Trilobite, was named *Olenellus forresti.*

The Ord River limestones are for the greater part hard and flaggy, rarely massive, usually grey in colour, sometimes sandy or magnesian, and seldom fossiliferous.(12) But in places where the rock is fossil-bearing, it is crammed with the shells of a small supposed Pteropod *(Salterella hardmani)* and innumerable pieces and bits of Trilobites. From the prevalence of the little shells I have been in the habit of referring to this rock as the "Salterella Limestone."

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(6) Ward: "The Geology of Tasmania: the Pre-Cambrian," Papers and Proc. Roy. Soc. Tas., 1909, p. 128.

(7) Woodward: Geol. Mag., i. (3), 1884, p. 342, pl. xi., figs. 2*a*, *b*, and 3.

(8) Etheridge: Trans. Roy. Soc. S. Austr., xxii., 1898, p. 1, pl. iv., figs. 1-3.

(9) Foord: Geol. Mag., vii. (3), 1890, p. 99.

(10) Glauert: Rec. W. Austr. Mus. and Art Gallery, i., pt. ii., 1912, p. 66.

(11) Foord: Geol. Mag., vii. (3), 1890, p. 99, pl. iv., figs. 2*a*, *b*, 3.

(12) Hardman: "2nd Rep. Geol. Kimberley Dist. W. Austr.," W. Austr. Parl. Papers, No. 34, 1885, p. 17, par. 124.

1892.—Prof. Tate described[13] both Molluscan and Trilobite remains from another locality on Yorke Peninsula, Curramulka. The latter were called *Microdiscus subsagittatus* and *Olenellus pritchardi*. Both at this locality and at the typical one, Ardrossan, Tate regarded the beds as Lower Cambrian or "Olenellus Zone," formerly termed by him Lower Silurian.

1895.—On the downs, five miles to the northward of Alexandria Cattle Station, Playford Creek, Northern Territory, in sinking a well, soft argillaceous rocks were met with to a depth of 200 feet. In the spoil from this well Mr. H. Y. L. Brown, the Government Geologist, found a Trilobite cephalon.[14] This I described as *Olenellus browni*.[15] The discovery and determination of this fossil, found in 1894, was the first definite record of the occurrence of Cambian rocks in the Northern Territory.[16] Mr. Brown cites a number of localities at which the lithological characters of this limestone formation are similar, and concludes by saying:—"The occurrence of Cambrian fossils near the Daly River and Alexandria Station proves that these widely-separated expanses of limestone are identical in age."[17] He had, however, previously stated his conviction that the limestone seen "at the Daly Telegraph Station, the Katherine River, and down the Victoria River was a continuation of that struck at the Alexandria Cattle Station bore."[18] In this limestone at the Katherine River, Dr. H. J. Jensen stated Mr. Brown found both *Salterella hardmani* and *Olenellus forresti*, but I am not acquainted with Brown's reference.

1896.—In 1896 appeared a paper by myself in which I suggested the presence of Cambrian rocks at Mount Ida, near Heathcote, in Victoria, basing my opinion on the presence of some fragmentary but very interesting remains, to which I gave the name of *Dinesus ida*.[19]

1902.—Two additional Trilobites from a further Cambrian locality, about 150 miles south-west of Alexandria Old Cattle Station, were obtained by Mr. Brown, and described

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(13) Tate: Trans. R. Soc. S. Austr., xv., pt. ii., 1892, p. 183, pl. ii., figs. 9, 11-13.

(14) Brown: "Report N. Territory Explorations," S. Austr. Parl. Papers, No. 82, 1895, p. 24, chart 8.

(15) Etheridge: "Off. Contrib. Pal. S. Austr.," No. 9. S. Austr. Parl. Papers, No. 127, 1897, p. 13, pl. i., fig. 1.

(16) Brown: "Northern Territory, etc., Reports Geological and General, 1905," S. Austr. Parl. Papers, No. 55, 1906, p. 14.

(17) Northern Territory, *Ibid*, p. *id.*, p. 14.

(18) Brown: "Report N. Territory Explorations," S. Austr. Parl. Papers, No. 82, 1895, p. 26.

(19) Etheridge: Proc. Roy. Soc. Vict., viii. (n.s.), 1896, p. 56.

as *Agnostus elkedraensis* and *Microdiscus significans*.(20) The precise locality is the deserted cattle station of Elkedra, in Lat. 21° S., Long. 135·22° E.

1903.—Prof. J. W. Gregory, in a paper entitled "The Heathcotian: a Preordovician Series and its Distribution."(21) described a further Trilobite from the Mount Ida beds as *Notasaphus fergusoni*. He expressed the opinion that my *Dinesus ida* comprised two forms, one of which he names as above, and further, that the deposit was not of Cambrian, but of Ordovician age.

The first record of organic remains in the Heathcote rocks was, I believe, by Prof. Sir F. McCoy, who recorded "cylindrical, flexuous markings, from one to two or scarcely three inches in length . . . usually attributed to annelid burrows, and are common in Cambrian rocks. . . . There is no reason for supposing from these specimens that the rock is older than Cambrian or Lower Silurian." (22)

Mr. E. Lidgey, in a report(23) on the general geology of the Heathcote Parish and others contiguous, refers to "micaceous mudstones containing casts of Trilobites," members of these Lower Silurian rocks occupying rather less than one-fourth of the area reported on.

An important survey was made by Mr. W. H. Ferguson "for the purpose of defining the boundaries of an outcrop of Cambrian strata known to occur in the parish of Knowsley East. The Trilobite beds outcrop along the valley of Lady Creek and consist of "micaceous mudstones very rich in fossils." From Mr. Ferguson's remarks it is clear that the geology of this district is complicated and obscure.(24) By the late Mr. T. S. Hall these bed rocks were regarded as of Lower Silurian age, "but low down in the series near the Cambrian horizon."

1904.—A further discovery of trilobite remains had been made about this time by Mr. Thomas Stephens (25) at the Florentine Valley, Humboldt Divide, West Tasmania. The fossils, casts of small Brachiopods, as well as those previously

(20) Etheridge: "Off. Contributions," etc., Nos. 12 and 13, 1902, p. 3, pl. ii.

(21) Gregory: Proc. Roy. Soc. Vict., xv., (n.s.), pt. ii., 1903, p. 152.

(22) McCoy: Vict. Ann. Rep. Secy. Mines, 1891 (1892), p. 30.

(23) Lidgey: Geo. Survey Vict., Progress Report, viii., 1894, pp. 44 and 45.

(24) Ferguson: Geol. Survey Vict. (n.s.), No. 2, Monthly Progress Report, May, 1899, pp. 23-25.

(25) Etheridge: Rec. Austr. Mus., v., pt. 2, 1904, p. 98, pl. x.

mentioned, are preserved in a yellow, slightly micaceous, somewhat fissile mudstone. A well-marked pygidium I termed *Dikelocephalus florentinensis*, and two others were referred with some doubt to the genus *Niobe*.

The Florentine River is a tributary of the River Derwent. Mr. L. K. Ward speaks of these fossiliferous beds as the equivalents of the Caroline Creek deposit.

1905.—Not far from Wirrialpa, in the Flinders Range, Mr. Howchin discovered a shelly band in a flesh-coloured oolitic limestone, containing Brachiopoda and remains of Trilobites. One of these latter was described as a species of *Olenellus*.(26) This locality is in the vicinity of the Blinman Mines, about midway between Lake Torrens and the south end of Lake Frome.

1907.—To all interested in the Cambrian geology of South Australia, and possibly that of Australia generally, Mr. W. Howchin's paper, "A General Description of the Cambrian Strata of South Australia,"(27) will be invaluable. He divided the beds into Upper ("Purple-slate") Series and Lower Cambrian Series. With the exception of the Brighton radiolarian beds, the fossiliferous horizons are limited to two limestones high up in the upper division, as at Parara, Curramulka, Sellick Hill, Blinman, and Wirrialpa, etc. Howchin estimates the Archaeocyathinae Limestone, in which the South Australian Trilobites occur, together with Brachiopods, Pteropods, and a Calcareous Alga, to have formed "coral" reefs in the Cambrian sea from one hundred to two hundred feet in thickness.

1908.—A preliminary paper(28) by Mr. F. Chapman revealed the presence of trilobite remains at the Dolodrook River, Mount Wellington District, Gippsland, in a hard and sub-crystalline limestone. Three forms were recognizable—an *Agnostus*, a *Proetus*, and a *Cheirurus*. The age of this limestone was at this period left an open question.

1911.—In a further paper during 1911 Mr. Chapman elucidated these fragmentary remains,(29) and considered the limestone to be of Upper Cambrian age. The occurrence of *Agnostus* is confirmed; the *Proetus* represented two species of *Ptychoparia*, whilst the *Cheirurus* proved to be a *Crepicephalus*.

(26) Etheridge: Trans. Roy. Soc. S. Austr., xxix., 1905, p. 247.

(27) Howchin: Rep. Austr. Assoc. Ad. Sci., xi., 1907 (1908), p. 414.

(28) Chapman: Proc. Roy. Soc. Vict., xxi. (n.s.), pt. i., 1908, p. 268.

(29) Chapman: Proc. Roy. Soc. Vict., xxiii. (n.s.), pt. ii., 1911, p. 305.

According to Mr. E. O. Thiele there are two limestones, a "pale grey," containing Brachiopods and *Girvanella* and a "dark bluish-grey," with the crustacean fragments in question,[30] "sections cut in all directions," says Mr. Chapman. This fragmentary condition of such remains is not uncommon in our Cambrian rocks, particularly in the Kimberley limestones and the friable sandstone of Caroline Creek.

1915.—In the "Bulletin of the Northern Territory" for December, 1915, are photo-prints of a Trilobite cast, found by Mr. Surveyor Merrotsy on the Barkly Tableland, eight miles east of Alroy Downs; "the rock matrix is a cherty replacement of limestone,"[31] which accords well with the lithological composition of the Ord River bed. This cast is described in the present communication as *Ptychoparia alroiensis*, and is the most perfect example of this group of animals yet found in the Australian Cambrian. Mr. Merrotsy's discovery is one of great importance, indicating a further extension eastwards in all probability of the series yielding *Olenellus forresti*, *O. browni*, *Agnostus elkedraensis*, etc.

1918.—Some years ago Mr. H. Y. L. Brown forwarded to me pieces of a grey-white limestone from Clinton, on the east side of Yorke Peninsula, at the head of Gulf St. Vincent. Throughout these limestone fragments are the broken-up remains of a Trilobite, which appears to me to be quite different from any one yet found in the Yorke Peninsula.

III. Observations on the Species.

Genus Agnostus, Brongniart, 1822

(Hist. Nat. Crust. Foss., 1822, p. 38).

Agnostus elkedraensis, Eth. *fil.*

A. elkedraensis, Eth., *fil.*: Off. Contributions Pal. S. Austr., No. 13 (S. Austr. Parl. Papers), 1902, p. 3, pl. ii., figs. 1-4.

Obs.—In addition to the comparsions already made in the above communication, attention may be called to another Cambrian species—*A. montis*, Matthew.[32] I have examined the specimens of this pretty Australian form, and cannot distinguish more than one thoracic segment. This absence of the second can hardly be a matter of development, as the normal number are acquired at a very early stage in the metamorphosis of the genus.

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(30) Thiele: Proc. Roy. Soc. Vict., xxi. (n.s.), pt. i., 1908.

(31) Anon.: Bull. N. Territory, No. 14, 1915, pls. ii. and iii.

(32) Matthew: Trans. Roy. Soc. Canada. v. (2), 1899, p. 48, pl. i., f. 6.

Loc.—Forty miles south-east of Elkedra Cattle Station (deserted), about 150 miles south of Alexandria Cattle Station, Barkly Tableland.

Hor.—Cambrian (Etheridge).

Agnostus australiensis, Chapman.

(?) *Agnostus*, sp., Chapman: Proc. Roy. Soc. Vict., xxi. (n.s.), pt. i., 1908, p. 268.

Agnostus australiensis, Chapman: *Ibid*, xxiii. (n.s.), pt. ii., 1911, p. 314, pl. lviii., figs. 9, 11, 12.

Obs.—The pygidium in this species differs from that of *A. elkedraensis* in the presence of the incipient spines at the posterior angles, and apparently by the absence of tubercles on the two lobes of the glabella.

Loc. — Dolodrook River, Mount Wellington District, Gippsland, Victoria.

Hor.—Agnostus zone, Upper Cambrian (Chapman).

Genus Microdiscus, Salter, 1864 (33)
(Quart. Jour. Geol. Soc., xx., 1864, p. 237).

Obs.—The name *Microdiscus* has a strange history as related by Mr. C. D. Walcott, and may have to give way to that of *Pemphigaspis*:—"If *Pemphigaspis bullatus* proves to belong to the same group [as *Microdiscus*] . . . all the species now referred to *Microdiscus* would then be replaced by *Pemphigaspis*, as Emmon's original name of *Microdiscus* would not be retained, as it appears to have been founded on a specimen of the genus *Trinucleus*." (34)

Whilst the name *Microdiscus* is retained it must be ascribed to Salter, as explained by Lake.(35)

Only one species of this strange little genus has so far been discovered in Australian rocks.

Microdiscus significans, Eth. *fil.*

***M. significans*, Eth. *fil.*:** Off. Contrib. Pal. S. Austr., No. 13 (S. Austr. Parl. Papers), 1902, p. 3, pl. ii., figs. 5-9.

Obs.—I am not in possession of any additional information relating to *M. significans*, which appears to be a member of the *M. dawsoni-puctatus* group, or those forms possessing a well-marked backwardly-directed cervical spine and multi-segmented pygidium.

I have re-examined the type specimens in the light of Mr. Walcott's genus *Pagetia*, but I failed to find any trace of either "eye line" (pelpebral ridge) or eyes.

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(33) Emended: Walcott. 1886; non *Microdiscus*, Emmons.

(34) Walcott: Bull. U.S. Geol. Survey, No. 30, 1886, p. 154.

(35) Lake: Mon. Brit. Cambrian Trilobites, pt. ii., 1907, p. 30.

To the original description may be added that the surface of each cheek rises into a low blunt tubercle.

Loc.—Associated with *Agnostus elkedraensis.*

Hor.—Cambrian (Etheridge).

Genus DINESUS, Eth. *fil.*, 1896
(Proc. Roy. Soc. Vict., viii. (n.s.), 1896, p. 56).

DINESUS IDA, Eth. *fil.*

***D. ida*, Eth. *fil.*: *Ibid*, p. 56, pl. i.**

***D. ida*, Gregory: *Ibid*, xv. (n.s.), pt. ii., 1903, p. 155. pl. xxvi., figs. 8-10.**

Obs.—On the subject of the fragmentary remains of this Trilobite, Mr. C. D. Walcott remarked:—"The genus *Dinesus*, Etheridge, jr., appears to be more nearly related to *Damesella* or *Dorypygella*, Walcott. Its marked characteristics are: the elongate oval glabella with the small, distinct antero-lateral and postero-lateral lobes; the small palpebral lobes; and the large pygidium with a spinose border."(36) A comparison with *Dorypyge* and several other genera will be found in the original description.

Prof. J. W. Gregory would combine the pygidia described by me as those of *D. ida* with his *Notasaphus fergusoni*, but too little of both these forms is at present known to define their respective limits.

Loc.—Near Mount Ida, near Heathcote, Victoria.

Hor.—Cambrian (Etheridge); Ordovician (Gregory); Cambrian or Lower Silurian (McCoy); Lower Silurian, "low down" (T. S. Hall).

Genus OLENELLUS, J. Hall, 1862
(15th Ann. Rep. N. York State Cab. Nat. Hist., 1862, p. 114).

OLENELLUS (?) BROWNI, Eth. *fil.*

***O. browni*, Eth. *fil.*: Off. Contributions Pal. S. Austr., No. 9 (S. Austr. Parl. Papers, 1897, No. 127), 1897, p. 13, pl. i., fig. 1.**

Obs.—It is impossible to assign this Trilobite to its correct generic position pending the discovery of more complete material, especially the pygidium, the structure of which would at once decide the question. So far as the characters are decipherable they appear to be those of *Olenellus*, more particularly from the fact that through the absence of facial sutures the "free cheeks" are in one with the other parts of the cephalic shield.

Loc.—Alexandria Cattle Station, Playford Creek, Barkly Tableland (110 miles north-west of Camoweal).

Hor.—Cambrian (Etheridge).

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(36) Walcott: Proc. U.S.A. Nat. Mus., xxix., 1905, p. 35.

Olenellus (?), sp.

Pl. xxxix., fig. 1.

Olenellus, sp., Etheridge: Trans. Roy. Soc. S. Austr., xxix., 1905, p. 247, pl. xxv., fig. 1.

Obs.—At present I am unable to refer this imperfect portion of a cephalon to any definite genus. The published figure does not convey a correct idea of the anterior outline, but represents the specimen terminating at the anterior margin of the glabella, whereas there is, in reality, portion of a wide concave area, anterior to the glabella, as in many other Trilobites; this alters the whole aspect of the specimen. There are but two pairs of furrows, instead of three, as I said in my former description, the basal pair complete and extending across the glabella, and an anterior pair very faintly marked, mere "nicks," in the axial furrows.

This imperfect glabella may be, as suggested by Mr. F. Chapman, an example of his *Ptychoparia thielei*, but before adopting this suggestion I prefer to await additional and more perfect material.

Loc.—Neighbourhood of Wirrialpa, Flinders Range, South Australia (Howchin).

Hor.—Cambrian (Etheridge).

Genus Ptychoparia, Corda, 1847

(Prod. Mon. böhm. Trilobiten, 1847, p. 25).

Ptychoparia (?) tatei, H. Woodward.

Pl. xxxix., figs. 2 and 3.

Dolichometopus tatei, H. Woodward: Geol. Mag., i. (3), 1884, p. 344, pl. xi., fig. 3.

Olenellus pritchardi, Tate: Trans. Roy. Soc. S. Austr., xv., pt. 2, 1892, p. 187, pl. ii., fig. 12.

Redlichia tatei, Walcott: Smithsonian Miscel. Collns., 64, No. 5, 1916, p. 539.

Sp. Chars.—Cephalon very minute, in all probability semicircular; glabella oblong and narrow, very slightly conical, arched, and apparently unfurrowed; axial furrows deeply impressed laterally, but interrupted at the distal end of the glabella by a low bridge, which crosses the anterior area to the cephalon-limb border, the area concave, and both it and the border wide. Fixed cheeks somewhat cornute in outline; ocular ridges, or "eye-lines" describing a wide obtuse curve, broad and prominent; neck ring lobate, deep; free cheeks unknown.

Obs.—The two first records of the above synonymy are founded on the study of four specimens: firstly, a replica of Dr. H. Woodward's *Dolichometopus tatei*, very kindly supplied by Dr. Smith Woodward; and secondly, Tate's three

type specimens of *O. pritchardi*, lent to me with great cordiality by Prof. W. Howchin.

I am quite unable to separate the above cephalons; I believe them to represent one and the same species. I do not quite follow Mr. Walcott in his reference of "*Dolichometopus tatei*" to the genus *Redlichia*. The fixed cheeks are so differently shaped, the direction of the ocular ridges so dissimilar, that the courses of the facial sutures must have been quite unlike those of the Indian genus. At the same time I am by no means satisfied by merely placing these partial cephalons in *Ptychoparia*.

On looking round for a similar structure to that I have here termed a "bridge," uniting the anterior end of the glabella to the limb border, the genera *Alokistocare*[37] and *Acrocephalites*[38] obtrude themselves. In the former, "a low rounded boss occurs in front of the glabella, that usually extends across the frontal limb (area) on to the frontal rim so as to interrupt the furrow delimiting the two"; the boss appears to be variable in development according to species. In the latter of the two foregoing genera this bridge is referred to as "a knob-shaped elevation," but in a cephalon placed in this genus with reservation by Mr. Walcott, the glabella is connected with the limb by a well-defined narrow median ridge.

Loc.—Curramulka (or Parara [?]), Yorke Peninsula, South Australia (Tate).

Hor.—Parara Limestone, Lower Cambrian (Tate); Upper Cambrian (Howchin); Cambrian (Etheridge).

PTYCHOPARIA (?) SUBSAGITTATUS, Tate.

Pl. xxxix., figs. 4 and 5.

Microdiscus subsagittatus, Tate: Trans. Roy. Soc. S. Austr., xv., pt. 2, 1892, p. 187, pl. ii., fig. 12.

Obs.—Tate's "*Microdiscus subsagittatus*" has no connection with the genus of that name. I have before me Tate's two specimens and two others lent to me by Prof. Howchin.

The resemblance between Tate's examples of his "*Olenellus pritchardi*" and "*Microdiscus subsagittatus*" is remarkable. In neither of the two type specimens of the latter is the true outline of the cephalon shown, but the fixed cheeks are slightly more cornute that in "*O. pritchardi*," the ocular ridges somewhat more sigmoidal. What, however, is of more

(37) Walcott: Smithsonian Miscel. Collns., 64, No. 3, 1916, p. 182.

(38) Walcott: *Ibid*, p. 174.

importance is the occurrence of traces of three pairs of very minute, ill-defined, and perhaps continuous glabella furrows. In the latter characters the replica of "*Dolichometopus tatei*" and the three examples of "*Olenellus pritchardi*" are indecisive; the neck ring of the most perfect of the *M. subsagittatus* specimens displays a well-marked central tubercle.

For some time I regarded these three—"*Dolichometopus tatei*," "*Olenellus pritchardi*," and "*Microdiscus subsagittatus*"—as one and the same, and I am not even now sure that I have done right in separating the last named from the other two; however, this course will probably please those who deal in microscopic specific differences.

Of Tate's illustrations that of "*O. pritchardi*" is substantially correct, but that of "*M. subsagittatus*" is imaginary.

Loc. and Hor.—Similar to last.

There is evidence of yet another Trilobite in these Yorke Peninsula Cambrian beds, as previously stated. Some years ago Mr. H. Y. L. Brown, late Government Geologist, presented to the Australian Museum examples of a whitish-grey limestone from Clinton, near the north-west corner of Gulf St. Vincent. Scattered throughout these hand specimens are portions of cephalons, thoracic segments, etc., but all fragmentary.

The glabella was of the same elongately-oblong type, slightly narrowing forwards as in the two last described forms. There are three pairs of furrows, the basal pair circumscribed, the two anterior pairs short, deep, and apparently not complete. The anterior area was very wide, concave, and with upturned limb, and, so far as I can see, an absence of the bridge uniting the anterior end of the glabella with the limb. The fixed cheeks are deltoid more or less; neck-ring wide with a central backwardly directed spine; the whole surface is minutely granular.

I do not think this can possibly be identical with any of the previously described cephalons, allowing for our limited knowledge of their complete structure, unless it be with *P. subsagittatus*. The very wide and concave area anterior to the glabella and upturned anterior limb seems to point to this.

Ptychoparia (?) australis, H. Woodward.

Pl. xxxix., fig. 6.

Conocephalites australis, H. Woodward: Geol. Mag., i. (3), 1884, p. 344, pl. xi., fig. 2*a*, *b*.

Sp. Chars.—Glabella oblong, almost parallel-sided posteriorly, the lateral margins barely tapering until near the

front, which is broadly rounded; glabella furrows in two pairs, the first pair all but circumscribing the basal lobes; axial furrows deep and well marked. Neck lobe in comparison to the size of the glabella broad and large, its furrow particularly deep. Fixed cheeks only partially preserved, but apparently wide. Surface minutely granular.

Obs.—The replicas do not display any traces of the facial sutures, ocular ridges, or eyes, nor is there any trace of the oblique striae "seen on the cheek in advance of the eye which spread from it to the anterior border of the glabella." The space occupied by an eye "on the anterior half of the head," as well as that by the oblique striae, appear to me merely as fractured matrix surfaces.

Loc.—Yorke Peninsula, South Australia (Woodward).

Hor.—Parara Limestone, Lower Silurian (Woodward); Lower Cambrian (Tate); Upper Cambrian (Howchin); Cambrian (Etheridge).

Ptychoparia (?) howchini, Eth. *fil.*

Pl. xl., fig. 7.

P. howchini, Eth. *fil.*: Trans. Roy. Soc. S. Austr., xxii., 1888, p. 2, pl. iv.

Obs.—At the time I described this imperfect cephalon I compared it with Woodward's "*Conocephalites australis*," but relying on the supposed accuracy of the figures given, believed them to be distinct. I now find the general aspect of the glabella of *P. howchini* to so closely resemble that of the replicas of Woodward's species that suspicion is raised of the identity of the two; but like so many other questions connected with these Cambrian Trilobites, this possibility must remain in that sense only for the present.

Loc.—Ardrossan, North-east Yorke Peninsula (Howchin).

Hor.—Lower Cambrian, or "Olenellus Group" (Tate); Upper Cambrian (Howchin); Cambrian (Etheridge).

Ptychoparia alroiensis, n. sp.

Pl. xl., fig. 8.

Trilobite cast., Anon.: Bull. N. Territory, No. 14, 1910, pls. ii. and iii.

Sp. Chars.—Cephalon semicircular (when perfect). Glabella obtusely conical, rounded in front, separated from the fixed cheeks and anterior limb by well-marked deep axial grooves; two pairs of furrows, the basal pair circumscribing prominent basal lobes; fixed cheeks comparatively large, but less convex than the glabella; palpebral lobes small, the connecting eye-lines, or ocular ridges, situated just in advance of the anterior pair of glabella furrows, anterior limb like the

fixed cheeks gently convex, in the same plane as the glabella, separated from the anterior margin or fillet, which is cord-like and prominent, by a shallow groove; neck-ring in its median portion comparatively thick, its groove well defined. Facial sutures in front of the palpebral lobes almost longitudinally straight, really very slightly convex, posterior to them curving downwards with a concave sweep and sharply outwards in the direction of the genal angles.

Thoracic somites fourteen[39]: axis elongately and narrowly obconical, gently convex; axial grooves wide and open. Pleurae arched, angular in the middle line, each strongly grooved or furrowed, the proximal half horizontally so, the distal obliquely bent. Pygidium small, of two (or perhaps three) coalesced segments, and a small terminal appendage; those of the pleurae deflected backwards to a slight degree; posterior margin truncate and nearly straight.

Obs.—I am indebted to both the Federal Director of Mines at Darwin and Corporal A. L. Merrotsy, 13th Field Company, Australian Engineers, for replicas of this Trilobite, from which the foregoing description was drawn up. I believe this to be the most complete Cambrian form yet found in Australia, and a very compact little body it is.

There appears to be, judging by Mr. C. D. Walcott's numerous figures, considerable latitude in the number of glabella furrows and tail segments in *Ptychoparia*: in the former from none to three (the last predominating), and in the latter from four to seven (again the last typical). In the present instance the facial sutures and number of thoracic segments are in order, but in the possession of only two pairs of glabella furrows, and a decreased series of pygidical segments, it is not in accord with strict precedent.

Loc.—Eight miles east of Alroy Downs, Barkly Tableland, Northern Territory (Merrotsy).

Hor.—Cambrian (Etheridge).

Genus Redlichia, Cossmann, 1902.

Hoeferia, Redlich: Cam. Fauna E. Salt Range (Pal. India, n.s., i., pt. 1, 1899), p. 2.

Redlichia, Cossmann: Revue Crit. Pal., 6th Ann., No. 1, 1902, p. 52.

Redlichia, Walcott: Proc. U.S. Nat. Mus., xxix., 1905, p. 24.

Obs.—Described by Dr. Redlich as a Trilobite with a semicircular cephalon, and free cheeks armed with genal spines; a cylindrical glabella provided with four pairs of furrows, and palpebral lobes which surround the glabella in

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(39) The first thoracic segment is not shown in the figure; it is more or less tucked under the neck ring.

continuous curves independent of the latter, and not confluent as in *Olenellus*. The fixed cheeks are very narrow, whilst the facial sutures are much pinched-in at the anterior ends of the palpebral lobes, giving to the antero-central portion of the cephalic shield a very characteristic "halbert"-shaped appearance.

To this genus I now refer *Olenellus* (?) *forresti*, Eth. *fil.*, and Foord, from Kimberley. A glance at Mr. A. H. Foord's figure[40] will at once reveal the very close resemblance existing between *O.* (?) *forresti* and Redlich's *Hoeferia noetlingi*, the type species of *Redlichia*, and following Mr. Walcott's suggestion[41] I now transfer it to that genus.

Redlichia forresti, Eth. *fil.* and Foord.

Olenellus (?) *forresti*, (Eth. *fil.*, m.s.) Foord: Geol. Mag., vii. (3), 1890, p. 99, pl. iv., figs. 2*a*, *b*.

Protolenus forresti, Matthew: Canadian Rec. Sci., v., 1892, p. 253.

Obs.—Mr. G. F. Matthew suggested the reference of this Trilobite to his genus *Protolenus* on account of its continuous eye lobes. He remarked that these continuous eye lobes "are close to the glabella, leaving a very narrow fixed cheek. The eye lobes and the middle piece of this head-shield are well defined, and give no reason for supposing that the outer cheek was fixed, without which the reference to *Olenellus* is inadmissible."

In opposition to Mr. Matthew's suggestion I would observe:—

1. The general appearance of the glabella, fixed cheeks, and eye lobes respectively in *Olenellus* (?) *forresti* is very different from that of Matthew's type, *Protolenus elegans*.

2. The glabella in *Protolenus* bears three pairs of lateral furrows, but in the Australian Trilobite these furrows are continuous, and said to be four in number.

3. In Matthew's type a pygidial telson is unknown, but he informs us that "such an appendage exists in a Sardinian species, and is like that of Paradoxides (or Olenus)." Mr. Foord remarked:—"From the same locality as the head just described there is a short spine (fig. 2*a*), probably belonging to the present species; if so, it would be the telson."[42] I, however, suggest it may be one of the genal spines and therefore quite in keeping with the structure of *Redlichia*.

(40) Foord: Geol. Mag., vii. (3), pl. iv., figs. 2*a*, *b*.

(41) Walcott: Smithsonian Miscel. Collns., 64, No. 1, 1914, p. 62.

(42) Foord: Geol. Mag., vii. (3), 1890, p. 99.

Again, Mr. Foord figured the half of a thoracic segment precisely like those ascribed to the same genus, grooved pleurae terminating distally in a short backwardly directed spine.

Loc.—(1) Elvira River bed, south of base line Z, 27 (H. B. 27); (2) Ord River bed, five miles below the Elvire Junction, opposite Hill J., 38 (H. B. 84).[43]

Hor.—Salterella Limestone, Cambrian (Etheridge).

I have before me a single poorly preserved specimen, like and yet unlike *R. forresti*. The glabella and fixed cheeks are the only portions of the cephalic shield clearly distinguishable. The former is narrow and cylindrical, decreasing in width forwards, with three continuous grooves. The fixed cheeks are wider than in *R. forresti*, and the palbebral lobes describe wider semicircles. The neck lobe is prominent and large, with a small central granule just above the posterior margin. There are five thoracic segments attached, each apparently bearing a central granule, or perhaps even a spine base, as that on the fifth axis is larger than the others, and projects exactly as the broken base of a spine would. The pleurae are short and, so far as the condition of preservation permits one to judge, of the *Redlichia* type. The fifth is distally terminated (seen on right-hand side) by a much longer, backwardly-directed acuter spine, longer than in the corresponding part of either *Redlichia noetlingi* or *R. forresti*. The precise relation of this fossil to the lastnamed Trilobite is not at present clear; it may be distinct, or, on the other hand, notwithstanding the trivial differences pointed out above, possibly an advance in the known structure of *R. forresti*.

Loc.—Kelley Creek, Ord River Station (Miss E. Helms).

Hor.—Salterella Limestone, Cambrian (Etheridge).

Redlichia thielei, Chapman.

Ptycoparia thielei, Chapman: Proc. Roy. Soc. Vict., xxiii., pt. ii., 1911, p. 316, pl. lviii., figs. 2, 3, 5, 7, 10.

Redlichia thielei, Walcott: Smithsonian Miscel. Collns., 64, No. 1, 1914, p. 62.

Obs.—By Mr. Walcott this species is referred to *Redlichia*,[44] and is remarkable in the possession of four pairs of glabella furrows. The presence of the long narrow glabella reminds us of that of those termed *Ptycoparia subsagittatus* and *P. tatei*.

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[43] Glauert: Rec. W. Austr. Mus. and Art Gallery, i., pt. 2, 1912, p. 72.

[44] Walcott: Smithsonian Miscel. Collns., 64, No. 1, 1914, p. 62.

Loc.—Dolodrook River, Mount Wellington District, Gippsland, Victoria (Chapman).

Hor.—"Agnostus zone," Upper Cambrian (Chapman).

REDLICHIA (?) MINIMA, Chapman.

Ptychoparia minima, Chapman: Proc. Roy. Soc. Vict., xxiii. (n.s.), pt. ii., 1911, p. 318, pl. lviii., figs. 1 and 6(?), pl. lix., fig. 22.

(?) *Proetus* (?), sp. nov., Chapman: *loc. cit.*, xxi. (n.s.), pt. i., 1908, p. 269.

Obs.—I think this form will be more appropriately placed in *Redlichia* than in *Ptychoparia*. The distinguishing features are the peculiarly dwarfed and semicircular palpebral lobes, which lend to this cephalon a somewhat remarkable appearance, and the "neck-ring showing traces of a slight ridge bearing three small blunt spines directed posteriorly."

Loc.—Dolodrook River, Mount Wellington District, Gippsland, Victoria.

Hor.—"Agnostus zone," Upper Cambrian (Chapman).

Genus DIKELOCEPHALUS, D. D. Owen, 1852

(Rep. Geol. Sur. Wisconsin, Iowa, and Minnesota, 1852, p. 573).

DIKELOCEPHALUS FLORENTINENSIS, Eth. *fil.*

D. florentinensis, Eth. *fil.*: Rec. Austr. Mus., v., No. 2, 1904, p. 25, pl. x., fig. 4.

Obs.—Known only as a pygidium, presenting the typical features of that of the genus. The axis consists of seven segments and a terminal appendage. The flattened side lobes consist of seven or eight pleurae, and there is a wide striated limb. From the ventral margin, opposite to the last but one pleura on each side, projects a short pygidial spine.

Loc.—Florentine Valley, Western Tasmania (T. Stephens).

Hor.—Cambrian (Etheridge).

Genus CREPICEPHALUS, D. D. Owen, 1852 [45]

(Rep. Geol. Sur. Wisconsin, Iowa, and Minnesota, 1852, p. 576).

CREPICEPHALUS ETHERIDGEI, Chapman.

(?) *Cheirurus*, Chapman: Proc. Roy. Soc. Vict., xxi. (n.s.), pt. i., 1908, p. 269.

Crepicephalus etheridgei, Chapman: *Ibid.* xxiii. (n.s.), pt. ii., 1911, p. 319, pl. lviii., fig 8.

Crepicephalus etheridgei, Walcott: Smithsonian Miscel. Collns., 64, No. 3, 1916, p. 203.

Obs. — The hitherto existing confusion between the genera *Dikelocephalus* and *Crepicephalus* has been dispelled

(45) Redefined, Walcott, 1916.

by the labours of Mr. C. D. Walcott. So far as the pygidia are concerned, those with broad flattened borders, or limbs, and the posterior spines when present short and thorn-like are *Dikelocephali*, whilst, on the other hand, similar pygidia with the spines extending backwards from a broad base long, narrow, and sharp; or the spines in question attached to the sides of the pleural lobes, appertain to *Crepicephalus*.

Loc.—Dolodrook River, Mount Wellington District, Gippsland, Victoria (Chapman).

Hor.—"Agnostus zone," Upper Cambrian (Chapman).

Crepicephalus tasmanicus, Eth. *fil.*

Dikelocephalus tasmanicus, Eth. *fil.*: Proc. Roy. Soc. Tas., 1882 (1883), p. 155, pl. i., fig. 4.

(?) *Conocephalites stephensi*, Eth. *fil.*: *Loc. cit.*, p. 153, pl. i., figs. 1-3.

Obs.—Misled formerly by the descriptions of the late Prof. James Hall, of Albany, I referred this pygidium to *Dikelocephalus*, but it appears to be that of a *Crepicephalus*, although not a highly typical one, owing to the narrowness of the posterior portion of the limb.

I am now of opinion that this pygidium, and the part cephalon I described at the same time as *Conocephalites stephensi*, will prove to be portions of one and the same species. Since my paper was written, now many years ago, I have examined a quantity of the Caroline Creek deposit. One result of this is an inability to find any pygidia likely to associate themselves with the "Conocephalites" cephalon other than the "Dikelocephalus" tail, or *vice-versa*. I can, therefore, only conclude they are one and the same.

The cephalon called *C. stephensi* was, I believe, one of the first, if not the first, Cambrian Trilobite portion to be described in detail from Australasia.

Loc.—Caroline Creek, near Latrobe, Tasmania (T. Stephens).

Hor.—Potsdam Sandstone or Lingula Flags (Etheridge); "Dikelocephalus Group" (R. M. Johnston); Upper Cambrian (L. K. Ward); Cambrian (Etheridge).

Genus Notasaphus, Gregory, 1903

(Proc. Roy. Soc. Vict., xv. (n.s.), pt. ii., 1903, p. 155).

Notasaphus fergusoni, Gregory.

N. fergusoni. Gregory: *Loc. cit.*, p. 155, pl. xxvi., figs. 11-13.

Obs.—The cephalon of *Notasaphus*, so far as known to us, is certainly distinct from that of *Dinesus*, but if the figures are a correct representation of the fossil, it is very difficult

to say to what genus the remains really belong; amongst other genera *Corynexochus*, or perhaps *Blountia*, may put in a claim.

Loc.—Neighbourhood of Mount Ida, Heathcote, Victoria (Gregory).

Hor.—Ordovician (Gregory); Cambrian (Etheridge).

Caroline Creek Trilobite Remains.

In my early account of these casts I figured, but left unnamed, portions of four cephalons. In each instance a glabella was preserved, parts of the neck-rings and anterior limbs, and traces of the fixed cheeks. All four types have certain features in common, such as the broad, short glabellae, deeply excavate anterior areas with thick and prominent limbs, and deep neck furrows; they differ only in proportional measurements and numbers of pairs of glabella furrows.

Since 1882 I have had opportunities to examine other examples of the Caroline Creek grit in which these remains occur plentifully, but always found the latter in the same tantalizing imperfect condition. In the absence of complete fixed and free cheeks it is most difficult to suggest a generic reference with any degree of certainty, but in my original remarks I compared one to *Loganellus*, Devine, and another to *Bathyurus*, Billings.[46] In a later communication I suggested *Ptychoparia*,[47] and for merely descriptive purposes perhaps here these cephala had better remain tentatively. At the same time other genera than those mentioned put in a claim, such as *Bathyurellus*, Billings; *Chuangia*, Walcott; or even *Pagodia*, Walcott.

Ptychoparia (?) carolinensis, n, sp.

Head shield, (?)*Conocephalites*, Etheridge: Proc. Roy. Soc. Tas., 1882 (1883), pp. 156 and 162, pl. i., figs. 8 and 9, (?) fig. 11.

Loganellus (?) or *Conocephalites* (?), Johnston: Syst. Acc. Geol. Tas., 1888, p. 37.

Chars.—Glabella broad-oval or oblong, rounded anteriorly, and all but in contact with the fillet of the anterior limb, broad posteriorly; fillet and neck-ring prominent, the neck furrow deep; two pairs of glabella furrows, basal and middle.

Obs.—The outline of the glabella (figs. 8 and 9) and that of fig. 11 are remarkably alike, and it is possible they may be identical as to species.

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[46] Etheridge: Papers and Proc. Roy. Soc. Tas., 1882-3 (1883).

[47] Etheridge: Trans. Roy. Soc. S. Austr., xxxii., 1882, p. 3.

PTYCHOPARIA (?) JOHNSTONI, n. sp.

Second species, Etheridge: Proc. Roy. Soc. Tas., 1882 (1883), pp. 157 and 162, pl. i., fig. 10.

Loganellus (?) or *Conocephalites* (?), sp., Johnston: Syst. Acc. Geol. Tas., 1888, p. 37.

Cars.—Glabella slightly pyriform, narrowing posteriorly, its anterior margin separated from the limb-fillet by a wide and deep frontal groove; limb-fillet thick and prominent; axial grooves deep and well marked; two pairs of pit-like furrows, basal and middle.

Obs.—Name suggested in memory of the late Mr. R. M. Johnston, Government Statist of Tasmania, etc. This is, in all probability, quite distinct from the original figs. 8, 9, and 11.

PTYCHOPARIA (?) TASMANIENSIS, n. sp.

Fragmentary head shield, allied to Bathyurus, Etheridge: Proc. Roy. Soc. Tas., 1882 (1883), p. 157, pl. i., fig. 12.

Bathyurus (?), sp., Johnston: Syst. Acc. Geol. Tas., 1888, p. 37.

Sp. Chars.—Glabella nearly quadrate, short, blunt anteriorly, but with the margin slightly rounded, expanding very little forwards; fillet of the limb narrow but prominent; fixed cheeks probably broad; neck furrow deep.

Obs.—Furrows are not visible on this glabella; it is shorter than either of the other forms, and blunter anteriorly.

In addition to the cephalic portions already described, there occur both in the Caroline Creek beds and those of the Florentine Valley certain pygidia of a very marked character.

Those from the first locality I tentatively referred to two forms of *Asaphus*.[48] They are nearly semicircular, differing rather in outline, but both with pronounced segmented axes, one with ten, the other eight segments. Both have well-marked striated limbs, but in one (fig. 6), the axis enlarges forwards much more rapidly than that of fig. 5.

The imperfection of the record renders accurate recognition of these pygidia difficult. A reference to *Bathyurus* even is, to some extent, possibly permissible, for although in most species of *Bathyurus* the pygidial pleurae are segmented, in *B. saffordi*, Billings,[49] only the axis is so, precisely as in the fossils under review. Furthermore, the glabellae, fixed cheeks, etc., are remarkably similar to those of that genus. In the same category stands *Asaphiscus*, Meek, but

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(48) Etheridge: Proc. Roy. Soc. Tas., 1882 (1883), p. 156. pl. i., figs. 5 and 6.

(49) Billings: Canadian Pal. Foss., i., 1865, p. 259, fig. 241.

here we are faced by the negative fact that no *Asaphiscus*-like cephalons have so far been discovered at Caroline Creek, that is to my knowledge.

In the Florentine Valley extension there also occur very similar isolated pygidia that I referred to *Niobe*.(50) In these tails, varying from semicircular (correct outline) to deltoid-triangular (distorted outline), are long, narrow, segmented axes, with indistinct traces of pleural subdivision on the lateral lobes. The limbs, as in those of the Caroline Creek specimens, are broad and continuous. In all probability, to whatever genus these latter pygidia may in the future be relegated, those occurring in the Florentine Valley will follow suit.

DESCRIPTION OF PLATES.

Plate XXXIX.

Olenellus (?), sp., or *Ptychoparia* (?), sp.

Fig. 1. Fragmentary cephalon (figured in Trans. Roy. Soc. S. Austr., xxix., pl. xxv., fig. 1). ×2 diam.

Ptychoparia (?) *tatei*, H. Woodward, sp.

Fig. 2. Imperfect cephalon, from a replica of Woodward's original specimen of *Dolichometopus tatei* (figured in the Geol. Magazine, i., 1884, pl. xi., fig. 3). ×8 diam.

Fig. 3. Imperfect cephalon, from one of Tate's original specimens of *Olenellus pritchardi* (figured in Trans. Roy. Soc. S. Austr., xv., pt. 2, 1892, pl. ii., fig. 11). ×4 diam.

Ptychoparia (?) *subsagittatus*, Tate, sp.

Fig. 4. Imperfect cephalon, from one of Tate's original specimens of *Microdiscus subsagittatus* (figured in Trans. Roy. Soc. S. Austr., xv., pt. 2, 1892, pl. ii., fig. 12). ×6 diam.

Fig. 5. Another similar example of Tate's, but not previously figured. The glabella furrows are distinctly visible in this specimen. ×6 diam.

Ptychoparia (?) *australis*, H. Woodward, sp.

Fig. 6. Imperfect cephalon, from a replica of Woodward's original specimen of *Conocephalites australis* (figured in the Geol. Magazine, i., 1884, pl. xi., figs. 2*a*, *b*). Nat.

Plate XL.

Ptychoparia (?) *howchini*, Eth. *fil.*

Fig. 7. Greater portion of a cephalic shield, from the original specimen (figured in Trans. Roy. Soc. S. Austr., xxii., 1888, pl. iv.). ×2 diam.

Ptychoparia alroiensis, Eth. *fil.*

Fig. 8. Nearly complete Trilobite, from a replica of the original specimen (figured in the Northern Territory Bulletin, 1910, pls. ii. and iii.). ×4 diam.

The illustrations were obligingly prepared for the writer by Mr. J. R. Kinghorn, of the Australian Museum, Sydney.

(50) Etheridge: Rec. Austr. Mus., v., No. 2, 1904, p. 26, pl. x., figs. 1-3.

Descriptions of Six New Species of Australian Polyplacophora (Four Acanthochitons and Two Callistochitons), with other Notes.

By Edwin Ashby, F.L.S., M.B.O.U.

[Read October 9, 1919.]

Plates XLI. and XLII.

Acanthochiton pilsbryi, Sykes.

Pl. xli., figs. 1 to 3.

A. pilsbryi, Sykes: Proc. Mal. Soc., vol. ii., pt. 2, July, 1896.

A. maughani, Torr and Ashby: Trans. Roy. Soc. S. Austr., vol. xxii., 1898.

I am indebted to Mr. James A. Kershaw, of the National Museum, Melbourne, for the opportunity of examining Sykes' type of the above shell. Sykes states that he had only the single specimen and did not disarticulate the anterior valve. An examination of the type at once gives the reason, for that valve, in common with several of the others, is badly broken. Further, the marked character of the sculpture of this shell is much obscured in the type owing to erosion and fracturing, but still more to the extensive limy encrustations, the deep interspaces between the pustules being in most cases entirely filled in with the accretions.

The very faulty drawings and description in Sykes' paper are undoubtedly due to this feature. Both Mr. Sykes and Dr. Pilsbry, to whom he submitted the type, emphasize the character of the dorsal area, narrow and well defined, but both ignore the characteristic feature of the shape and arrangement of the general sculpture so striking in good specimens of this shell.

A. pilsbryi, method of sculpture in pleural area.

Description of sculpture referred to:—In the pleural area the pustules are about twice as long as broad, are square-ended and set in rows on the diagonal, so that one corner only reaches the upper line, the interspaces between the rows being a series of almost square hollows, the direction of the row of pustules is parallel with the dorsal area. A limited amount of bridging connects the pustules of one row with those of the next row. In the lateral area the row

becomes curved and the pustules larger, more raised, and rounded.

Hab.—Victoria and South Australia.

ACANTHOCHITON PILSBRYI MAUGHANEANUS, n. sp.

Pl. xli., fig. 4.

Differs from *A. pilsbryi*, Sykes, in having pustules less raised and rounded. The pustules are even more rectangular than is the case in the dominant form; in the anterior valve they are about twice as long as wide, straight-sided and square-ended, narrower as well as being less raised. While probably the number of pustules is about the same, owing to their being more slender the interspaces are proportionally wider. In the median valves the pleural area is markedly different from *A. pilsbryi* in that the pustules are very slightly raised, are long and slender, with greater space between the rows. Also the bridging in the species under description is more complete, a raised ridge joining the posterior portion of one pustule to the anterior portion of the corresponding one in the row above, thereby increasing the honeycomb appearance so characteristic of the southern and dominant species. The pustules in the lateral area are more raised and larger than in the pleural, but this feature is less pronounced than in *A. pilsbryi*.

Hab.—Sydney Harbour, New South Wales.

Remarks.—Owing to the recognition of Dr. Torr's and my *A. maughani* as Sykes' shell, that name becomes a synonym of *A. pilsbryi*. I am therefore preserving the name of Mr. M. M. Maughan, the ex-Director of Education in this State, by naming the subspecies after him.

The type I am presenting to the South Australian Museum; it was collected by myself at Middle Harbour, Sydney, New South Wales.

Genus ACANTHOCHITON, Gray, 1821.

Subgen. NOTOPLAX PORCINA, n. sp.

Pl. xli., figs. 7 to 10.

General appearance.—Shell elongated, glossy, carinated, side slope straight, all valves more or less covered with fine longitudinal ribbing.

Colour and markings.—Light vinaceous-cinnamon, mottled with congo pink in the dorsal areas (Ridgway's Colour Standards, pl. xxviii. and xxix.).

Anterior valve.—Has five shallow undulations or ray ribs, is fairly evenly covered with wavy, concentric ribbing; in character these resemble "ripple marks" on the sea sand. These marks turn inwards towards the apex of valve along the central rib. Near the apex the "ripple marks" are crowded

and broken into incipient, flattened pustules. Insertion plates, porcelain white, slits five, broad.

Posterior valve.—Mucro very distinct, posterior, the anterior portion of valve is similar in sculpture to the pleural and lateral areas in other valves. A diagonal depression separates this from the posterior portion, the ribbing being deflected downwards and its character somewhat altered, the ribs here showing a tendency to become granulose, still further changing when the posterior part of valve is reached, the shell there being covered with closely-packed granules without any system of arrangement. Insertion plates white, one broad slit on each side and four, and suggestion of a fifth, immediately behind the mucro.

Median valves.—The dorsal area is longitudinally lined with whitish lines separated from one another by darker lines which look like grooves, but under a stereoscopic microscope the surface is found to be practically ungrooved longitudinally, but crossed by shallow transverse sulci. Strictly speaking there is some evidence of shallow longitudinal grooving existing in places; this feature may be more marked in other specimens.

The pleural area is covered with close, wavy, longitudinal ribbing, the ribs are more abrupt on the lower side, and the trough between them is broad and shallow; both ribs and trough are diagonally scratched or minutely grooved. The lateral area is sculptured in a similar manner to the pleural, but the ridges are deflected upwards on reaching the diagonal undulation, it can barely be called a rib, which separates the two areas; the lateral area is very small compared with the pleural. Inside of shell white, median valve one slit, sutural laminae produced very little forward, sinus broad and sinuate.

Measurements.—35 mm × 11 mm. in dried specimen.

I am indebted to Dr. W. G. Torr for the opportunity of describing this very fine *Acanthochiton*; it was dredged in Gulf St. Vincent, South Australia. Up to the present only one specimen has been met with. The type will remain for the present in Dr. Torr's collection, but ultimately it will be placed in the South Australian Museum.

Remarks.—This species can easily be distinguished from *Notoplax matthewsi*, Bed. and Pils., by the ribbing being continuous and not broken into granules, the ridges are less strong, and the pinnatifid character of the dorsal area, so marked in *N. matthewsi*, is almost absent in this species. It is more nearly allied to that species than to any other *Acanthochiton* known to me. The specific name is derived from the Latin *porca*, meaning a ridge between furrows.

ACANTHOCHITON MAXILLARIS, n. sp.

Pl. xli., figs. 5 and 6; pl. xlii., fig. 1.

General appearance.—Shell long, rather flat, sides slightly rounded, dorsal area much rounded, width of shell less than half its total length, dorsal area broadly wedge-shaped, all the valves are covered with longitudinal rows of rather large, rounded, mostly porcelain-white pustules, the outer row or rows being irregular in arrangement, all pustules in these being much larger than those in the upper rows and some being twice as long as their neighbours and mammiliform; here and there there is a tendency for these large pustules to coalesce.

Colour.—Shrimp-pink varying in places to geranium-pink (Ridgway's Colour Standards, pl. i.), the girdle is Brussels brown, this colour occurring also in places in the ground-colour of the shell mottled in with the pink. The milk-white or porcelain-white pustules contrast strikingly with the general ground-colour of the shell.

Anterior valve.—This valve is too broken to disarticulate, is clothed with white pustules smaller towards the apex, and larger and more rounded towards the girdle; there are evidences of ray ribs, probably five, this feature being so common to Acanthochitons.

Posterior valve.—Mucro posterior, dorsal area similar to median valves, broadly wedge-shaped and flat and transversely finely ridged. Balance of valve covered with closely-packed granules, greyish or transparent white, but the granules of the outer row forming the edge of the tegmentum are twice as large as the rest, broad and round, packed closely together, and porcelain-white in appearance. This outer row of pustules gives a scalloped look to the margin of the tegmentum. Inside white, tinged in places with pink, slits two, the sutural laminae form almost three sides of a square with rounded corners.

Median valve.—Dorsal area very broad, subcutaneously lined with olive lines, transverse and longitudinal striae, the latter very indistinct. Apex is formed into a broad, rounded, flat beak, which overhangs and is distinctly rugose. The pleural and lateral areas are hardly separable, and there is a considerable margin of variance between the different valves but all show three or four longitudinal rows of rounded or oval, distinctly separated, milk-white pustules, those next the dorsal area are rather smaller than the lower row, then follows a row of milk-white pustules, fully three times the size of the upper row, and more or less placed alternately, short and long, looking like a row of irregular, rounded teeth set in a jaw, between this row, which rather follows the lines of growth

than being strictly longitudinal, and the outer margin, are a few irregularly-placed elliptical or rounded pustules, some milk-white, others dark. Inside white, slits one, ill defined, and placed far back on the insertion plate, suture broad.

Hab.—Marino, South Australia. Collected by myself; only one specimen on rocks at low tide.

Girdle.—Spongy, but in places scattered minute spicules can be detected, towards the outer margin there are evidences of minute scales; it is possible that the scales have broken away from the older parts of the girdle. A fairly conspicuous hair-tuft is placed at each suture, but the spicules are short.

Measurement.—7 mm. × 3 mm.

Remarks.—This beautiful and striking *Acanthochiton* is easily distinguished from any known species by the row of exceptionally large milk-white pustules suggesting a row of rounded teeth set in a jaw, present in the median valve. The name is derived from the Latin *maxilla*, a jaw. The type I am for the present keeping in my own collection, but ultimately I hope to place it in the South Australian Museum.

Acanthochiton gatliffi, n. sp.

Pl. xlii., figs. 2 to 5.

General appearance.—Shell twice as long as broad (dried specimen), side slope very slightly curved, dorsal area broadly wedge-shaped, much raised, rounded transversely and longitudinally, valves covered with curved longitudinal rows of rather large, raised, flat pustules.

Colour.—The dorsal areas are deep Hellebore red, and the girdle and most of the ground-colour of the rest of the shell Dresden brown, the red merging into the brown; the pustules are a lighter shade than the portion of shell on which they are placed. (Ridgway's Colour Standards, pls. x., xxviii., and xv.)

Anterior valve.—Five rays or undulations, the whole valve uniformly clothed with whitish, elliptical, raised pustules, well separated from one another but not placed in defined rows; these pustules are smaller and less flat than are those on the median valves. Inside and insertion plates deep pink, five slits, teeth sharp.

Posterior valve.—Very small, mucro slightly posterior, dorsal area wedge-shaped but smaller in proportion than the other valves. The portion of shell to the front of the mucro is ornamented with a few large flat pustules in two rows, the posterior portion of valve decorated towards its margin with two rows of small granules. Inside pink, slits three, the insertion plates are produced posteriorly for a width almost equal to half of the exposed portion of valve, sutural laminae are produced sideways to an unusual degree almost forming a point, sinus broad.

Median valves.—The dorsal area broadly wedge-shaped, highly arched, longitudinally convex, beaked, pinnatifid. The markings and sculpture are a little difficult of definition, there is present a series of whitish spots arranged longitudinally on a dark-pink ground, the wavy longitudinal and transverse striae together with the colour markings give a granulose appearance to the whole of this area, which may be described as looking like strings of very small granules separated by dark-pink lines. The pleural and lateral areas are inseparable, are traversed by widely spaced, rather coarse, raised but flat pustules, under microscope they look like whitish, flat topped flagstones laid on the crown of raised portions of the tegmentum. Inside pink, insertion plates pink, slit one.

Girdle.—Spongy, a few scattered short spicules and an incipient fringe. Hair tufts well defined, spicules short.

Measurement.—The type (dry) measures 5 mm. × $2\frac{1}{2}$ mm., being a little curved, probably 6 mm. would be nearer correct. Mr. Gatliff's shell 6 mm. × 3 mm. and Mr. Gabriel's shell 8 mm. × 4 mm.

The type remains for the present in my collection but I shall hope ultimately to place it in the South Australian Museum.

Hab.—I collected the type myself at Port Lincoln, South Australia, and sent two others, collected at the same place and time, to Mr. Iredale as being the same; but until these are returned to me and I can examine them under a microscope I cannot absolutely determine their identity. Messrs. Gatliff and Gabriel have both loaned me single specimens obtained off Point Cook, Port Phillip, Victoria, in 8 fathoms.

Remarks.—I am indebted to the two gentlemen above named for the oppportunity of examining their specimens; they exhibit a few minor differences. Neither show the pink colouration which is such a marked feature in the type; it is possible that their specimens may at one time have been in spirit which would remove the colour. Mr. Gabriel's shell, which is the largest of the trio, has a distinctly rugose dorsal area, becoming granulose toward the beak: the pinnatifid character of this area is more distinct, and there are evidences of very minute scales on the girdle and of a girdle fringe.

This interesting little Acanthochiton has been in their collection for some years, but was wrongly identified by them as Sykes' shell *A. pilsbryi*, a species dealt with in the earlier portion of this paper.

I am naming this shell after Mr. Gatliff, who with his colleagues has done much good work on the Victorian fauna.

CALLISTOCHITON ANTIQUUS MERIDIONALIS, n. sp.

Pl. xlii., fig. 7.

Introduction.—In setting out to describe a new form of *Callistochiton* I collected on the North-west coast of Tasmania I have been compelled to examine specimens from the type locality, New South Wales, which was described under the name *C. antiquus* (pl. xlii., fig. 6) by Reeve in 1847, and compare them with the Tasmanian shells and South Australian shells, with the result that I find that our South Australian shell must receive a distinguishing name before the new Tasmanian shell can be put in its right niche in our classification.

Description of differences.—In the South Australian shell the longitudinal ribbing in the pleural area is broader, less elevated, more wavy and granulose than in the shell from New South Wales, also instead of running parallel to the midline they are deflected somewhat towards it. The bridging of the South Australian shell is only slightly lower than the ribs, whereas in the northern shell the bridging is deep, not standing up nearly as high as the longitudinal ribs; also the transverse ridges on the two lateral ribs are less elevated, further apart, and more numerous in the South Australian form. A still more striking difference is revealed when the valves are disarticulated. The anterior margin of the tegmentum is almost straight in the Sydney shell, but in the South Australian one it is produced forward almost to a point. The sutural laminae are broad and straight-edged in the northern shell, but are narrow and more produced forward in the South Australian shell. Another marked feature is that while in both the articulamentum is continued in front of the tegmentum across the sinus, in the South Australian shell it is divided into minute teeth—I counted 10 slits—the edge of each of the minute teeth is curved, giving a scalloped margin to this portion of the articulamentum, whereas in the Sydney shell it is straight-edged, the slits being suggested by slight grooves. I am suggesting the subspecific name of *meridionalis* for the South Australian shell. I have found this shell whereever I have collected in this State.

Type is from Marino. I am presenting it to the South Australian Museum.

CALLISTOCHITON ANTIQUUS MAWLEI, Iredale and May.

This species was described from Port Arthur, South-eastern Tasmania by Messrs. Iredale and May. It differs again from either of the foregoing in that the longitudinal ribbing is persistent right over the dorsal area, the irregular network present in the two former being absent. The longitudinal

ribbing corresponds with the South Australian shell in the width of the ribs, but they are almost straight, nearer together, the bridging greatly thickened and proportionately shorter.

The transverse ridges in the two lateral ribs are present as mere nodules, irregularly spaced and not as sharp strongly elevated ridges as in the two preceeding. This form easily takes its place as a subspecies of Reeves' *Callistochiton antiquus.*

Callistochiton antiquus mayi, n. sp.

Pl. xlii., figs. 8 and 9.

The only opportunity I have had of collecting Chitons in North-western Tasmania was limited to one afternoon on October 11, 1916, when I had an hour or so on the rocks at a place called Penguin. Amongst the shells then collected was a small *Callistochiton* quite new to me, which I concluded and put aside as being Iredale and May's new Callistochiton *C. mawlei*, which I had not then seen. Since then my friend Mr. May has given me a specimen of that shell, and I find that the Penguin shell is quite distinct. I sent it over to Mr. May for his opinion, and he concurs with my view. I propose naming if after Mr. May as an acknowledgement of the help he has been in the elucidation of Tasmanian Chiton fauna.

Description of differences.—This species differs from any of the preceeding in the entire absence of longitudinal ribbing. The whole pleural area is reduced to a network of which the strands are so thick that the holes between are nearly filled in, in the dorsal area this is absolutely the case, nothing but fine granulose sculpture remaining.

Under a pocket lens the pleural and dorsal areas appear simply granulose, the network origin of the sculpture is quite lost. Under a higher power, however, the network sculpture survives in the form of numerous pits scattered towards the anterior margin.

The transverse ridges in the lateral ribs are almost as defined as in the South Australian shell, but these ridges are more numerous and closer together. Measurement, 8 mm. × 5 mm. I consider this species diverges most from the dominant form of all the subspecies here dealt with.

Remarks.—In the absence of the examination of the Victorian *Callistochiton* fauna, our knowledge of the effect or otherwise of the Bassian Isthmus (Hedley: Proc. Linn. Soc. N.S. Wales, xxvii., 1904) on the distribution of this genus is very incomplete. In some respects the South-eastern Tasmanian shell shows affinities with the Sydney shell; but the North-western Tasmanian shell is certainly more closely allied to the South Australian than either of the other two. This is certainly suggestive but inconclusive, until more Victorian material is examined. I hardly think any additional word is

needed to justify the placing of the four very distinct forms herein dealt with under the specific name of *C. antiquus*, Reeve, as subspecies thereof. I take it that true science is better served in showing their affinities, rather than magnifying their differences. We may conclude that all four species have a common ancestry, but that each of the widely separated localities has developed a fixed type of its own.

In conclusion.—In my list of Australian Polyplacophora (Trans. Roy. Soc. S. Austr., vol. xlii., 1918) under the heading *Callistochiton*, two species and one subspecies were given, *viz.*, *C. antiquus*, Rve., 1847; *C. recons*, Thiele, 1911; and *C. mawlei*, Ire. and May, 1916, the lastnamed being recorded as from both South Australia and Victoria. As regards the first it certainly was incorrect, and as far as I am aware it has not yet been found in Victoria.

Two more must be added to the list now, bringing the total to five, and it is very probable that the very beautiful shell described by Dr. Torr as *Ischnochiton bednalli*, may have ultimately to be referred to this genus; I have not yet seen a disarticulated specimen, so cannot express a definite opinion. Undoubtedly the network sculpture is suggestive of this genus, but in some other respects it does not show any very close affinity with any of our known Australian forms.

Since finally typing the foregoing paper I have turned up Iredale and May's description of *C. mawlei* (Proc. Roy. Soc., vol. xii., pts. ii. and iii., Nov. 1916) and cannot refrain from quoting their concluding remarks on the differences: "in the formation of the sutural laminae, these are continuous, whereas they are widely separated in the species *C. antiquus*, Reeve, and even more so in the South Australian species."

Mr. S. Stillman Berry, of California, writes me on July 1, 1919:—"Your alcoholic specimens of *Callistochiton* (from South Australia) do not look like the dry *antiquus* from Sydney." I think it probable that when the Victorian fauna is fully investigated we shall recognize two distinct species, *C. antiquus*, extending from Queensland down the East Coast, finding its extreme southern limit in Port Arthur, in Tasmania, where the subspecies *C. mawlei*, I. and M., is its representative, and a western species, extending from the submerged Bassian Isthmus through South Australia and Western Tasmania to Western Australia, of which the dominant form will be *C. meridionalis*, herein described, with *C. mayi*, also described herein, as its subspecies.

Addenda.—After completing the draft of the foregoing paper I received from Mr. C. J. Gabriel, of Melbourne, an *Acanthochiton* which he had compared and identified with Sykes' type of *A. pilsbryi* in the Melbourne Museum. Mr.

Gatliff had previously sent me a smaller shell of same species that he had also identified with Sykes' type. I felt that to go counter to two such able conchologists needed assurance made doubly sure, and therefore wrote Mr. Kershaw asking that he would be good enough to loan me Sykes' type again with permission to disarticulate another valve and clean same, because in its then encrusted and stained condition an element of almost intuition enters into its determination. Mr. Kershaw has sent me the type with the permission asked for. I was disappointed at finding that every valve was fractured, but have successfully disarticulated the second valve, which although considerably broken has sufficient sculpture remaining for the purpose. I can, now it is cleaned, authoritatively state that *Acanthochiton maughani*, Torr and Ashby, is cospecific with Sykes' shell *A. pilsbryi*, and is therefore a synonym; also that Messrs. Gatliff and Gabriel's shells from Point Cook, Port Phillip, Victoria, are fine specimens of my Port Lincoln shell that I am naming *A. gatliffi*. I have photographed under a high magnification the cleaned valve of Sykes' type with a corresponding valve of *A. maughani* from the type locality, Port Victor. This photo is reproduced herein, and will, I trust, demonstrate to the satisfaction of all workers my contention.

Photography.—I have contended for a long time that for purposes of accurate determination photography should be much safer than the work of an artist however well executed. While good photographs are comparatively easy at low magnifications, its difficulty is greatly increased under high magnification; this of course is especially the case with the carinated shells of Chitons. Further special methods of lighting have to be made use of to bring out the sculpture. The species under review has been figured three times—Proc. Mal. Soc., vol. ii., pl. ii., July, 1896, drawn by J. Green for Sykes; again in Trans. Roy. Soc. S. Austr., vol. xxii., 1898, figs. 5, *a*, *b*, *c*, *d*, and *f*, pl. vii., under the name of *A. maughani*, drawn by C. Hedley for Torr and myself; and lastly, the New South Wales form in Rec. Austr. Mus., vol. vii., No. 4, 1909, figs. 24, 25, 26, and 27, pl. lxxiv., drawn by Miss W. West for Messrs. Hedley and Hull. While the lastnamed figures are beautifully executed and a great advance on earlier attempts, the true character of the remarkable sculpture of the pleural area is not delineated. No further apology is needed for the presentation of the photos of this shell as attached to this paper. It is a satisfaction to have been able to clear up a long standing difficulty, and my thanks are due to Dr. Torr and Messrs. Kershaw, Gatliff, and Gabriel for the examination of material that has helped towards the solution of the problem.

DESCRIPTION OF PLATES.

Plate XLI.

Australian Polyplacophora.

Fig. 1. *Acanthochiton pilsbryi*, Sykes, ×10, from S. Austr.
" 2. " " " ×23, type, median valve.
" 3. " " " ×23, from S. Australia, median valve.
" 4. " " *maughaneanus*, Ashby, ×28, median valve.
" 5. " *maxillaris*, Ashby, ×28, posterior valve.
" 6. " " " " median valve.
" 7. " *porcina*, Ashby, ×1¾.
" 8. " " " ×6, anterior valve.
" 9. " " " " median valve.
" 10. " " " " posterior valve.

Plate XLII.

Australian Polyplacophora.

Fig. 1. *Acanthochiton maxillaris*, Ashby, ×10.
" 2. " *gatliffi*, Ashby, ×11.
" 3. " " " ×28, anterior valve.
" 4. " " " " posterior valve.
" 5. " " " " median valve.
" 6. *Callistochiton antiquus*, Reeve, ×15, median valve, from New South Wales.
" 7. " " *meridionalis*, Ashby, ×15, median valve, from S. Austr.
" 8. " " *mayi*, Ashby, ×15, median valve, from Tasmania.
" 9. " " " Ashby, ×15, anterior valve, from Tasmania.

Physical Properties of Some South Australian-Grown Pines.

By Professor R. W. Chapman, M.A., B.C.E.

[Read October 9. 1919.]

The tests about to be discussed were made upon timbers supplied to the Engineering Laboratory at the University by the courtesy of Mr. Walter Gill, Conservator of Forests. They reached the Laboratory in June, 1917, in the form of beams 6 ft. 6 in. long, and either 6 in. × 4 in. or 4 in. × 2 in. in section, all cut from recently-felled tress grown under inside plantation conditions. They were of three species, *i.e.*, Canary Island Pine *(Pinus canariensis)*, Remarkable Pine *(Pinus insignis)*, and Maritime Pine *(Pinus maritima)*, all of which have been extensively planted in this State. The specimens of *Pinus canariensis* were from two trees grown in Plantation A, Bundaleer Forest Reserve, and felled on May 21, 1917. One tree was 68 and the other 71 ft. high, and each was 15½ in. in diameter at the base, and showed 39 rings. The *Pinus insignis* species were from two trees grown on a sandy loam over clay subsoil at Wirrabara Forest Reserve, one being 20 and the other 30 years old at the time of felling, and from a tree 33 years old grown on a loamy flat over a volcanic deposit at Mount Burr Forest Reserve. The species of *Pinus maritima* come from a tree 30 years old grown at Wirrabara and from another tree 33 years old grown at Mount Burr. All the trees had been freshly felled about a fortnight before the timber reached the Laboratory.

When the timber was received each piece was properly branded and weighed, and a remarkable difference was noticed between the weights of timbers of the same species from different trees. Thus the average weight of the 6 in. × 4 in. pieces of *Pinus insignis* from the 30-year-old tree from Wirrabara was 38·42 lbs., or 35·46 lbs. per cub. ft., those from the 20-year-old tree in the same locality averaged 56·83 lbs., or 52·46 lbs. per cub. ft.; while those from Mount Burr averaged no less than 72·25 lbs., or 66·69 lbs. per cub. ft., being actually heavier than water. This difference, however, turned out to be almost entirely due to the moisture contents of the wood, and after storing for two years in the Laboratory the average weights per cub. ft. for these three trees were 25·94, 28·90, and 29·69 lbs., respectively, or an average of 27·86 lbs. per cub. ft. for the whole. Similarly the *maritima* 6 in × 4 in. pieces from Wirrabara in June, 1917, averaged 59·33 lbs. or 54·76 lbs. per cub. ft.; while those from Mount

Burr weighed 65·58 lbs., or 60·53 lbs. per cub. ft. But after seasoning for two years the weights per cub. ft. were 31·29 and 35·69 lbs., respectively, the whole set averaging out at 32·96 lbs. per cub. ft. The 6 in. × 4 in. pieces of *Pinus canariensis* weighed on the average 65·42 lbs., or 60·4 lbs. per cub. ft. on receipt at the Laboratory, but reduced finally to 41·83 lbs. per beam, or 38·61 lbs. per cub. ft. Some of the *insignis* beams from Mount Burr contained as much as 158 per cent. of moisture, calculated on the dry weight of the timber, but the moisture contents of all the timbers had fallen to about 11 or 12 per cent. by March, 1919.

Even when dried to approximately the same percentage of moisture contents there was a considerable difference in the weights per cub. ft. of the timber from the three trees from which the *insignis* beams were cut, and an analysis of the results of the tests on the seasoned wood shows that this difference in weight was accompanied by a corresponding difference in strength. With the notable exception of the beam tests for the 20-year-old tree from Wirrabara the strengths were very nearly proportional to the densities of the timber, as the following table shows:—

Ratios of Densities and Strengths of *Pinus insignis*. *Timber from Different Trees.*

	From Wirrabara. 30 years old.		From Wirrabara. 20 years old.		From Mount Burr. 33 years old.
Ratio of densities	1	:	1·11	:	1·14
Ratio of strengths in compression along the grain ...	1	:	1·08	:	1·21
Ratio of shearing strengths ...	1	:	1·09	:	1·20
Ratio of strengths of beams	1	:	0·91	:	1·17

Similar results, however, were not found to apply to the *maritima* tests. Here again the timber from Mount Burr was considerably heavier than that from Wirrabara, both when green and when seasoned; but the tests showed that the Mount Burr timber was distinctly the weaker. Tested as beams the ratio of the strength of the Mount Burr timber to that from Wirrabara was 13 : 21, and in all tests except shearing the denser timber was inferior to the other. Density is evidently by no means the only factor in determining the strengths of woods, even of the same species.

The tests made upon the timbers comprised measurements for shrinkage with seasoning, transverse tests carried out on beams 6 ft. between supports and either 6 in. × 4 in. or 4 in. × 2 in. in section, shearing tests, and determinations of the strength of the timber in compression both longitudinally

and across the grain. The tests were made in the same manner as those described in the author's paper on "The Strength of South Australian Timbers," in Trans. Roy. Soc. S. Austr., vol. xxxii. On the whole over 350 tests were made on the three species, so that fair average determinations could be made. In addition a number of tests were made upon samples of oregon purchased at local timber mills. As this is an imported timber largely used for construction it was thought that the comparison would be useful.

With every test a determination was made of the moisture contents of the wood as soon as possible after the test was completed. In the case of beams this was done by boring two large auger holes into the beam near the break. The shavings from these holes were then put into weighing bottles, to protect them from the drying effects of the air, and weighed. The bottles were then put in a drying oven, the tops being removed, and they were kept there at a temperature of about 104° C. for 5 hours. The tops of the bottles were then replaced and, after being allowed to cool the bottles were again weighed. The moisture determination is very essential, because the strength of many species of wood diminishes very greatly as the moisture contents increase, and a test of its strength is practically valueless unless it is accompanied by a measurement of the moisture contained in it. It makes no difference whether this moisture be in the form of the original sap or whether it be due to water that has soaked into the wood after seasoning. In either case the strength of the wood with a given percentage of moisture will be the same.

In order to examine the question of the variation of strength with moisture contents more thoroughly than could be done by making tests on the timber as it was seasoning, 48 blocks, each 2 in. × 4 in. and 5 in. long, were cut out of a seasoned beam of *Pinus insignis*. The determinations showed that this beam contained 11 per cent. of moisture, as calculated on the dry wood, and as it had been stored in the Laboratory for two years in a dry place, the moisture contents were fairly uniformly distributed. The blocks were each separately marked and weighed, and three of them were tested in compression along the grain, the average strength being 4,462 lbs. per sq. inch. The remainder were then kept immersed in water for four days. They were then removed and allowed to gradually dry out to their original condition. At first they dried rapidly, and two or three blocks were weighed each day, to determine their moisture contents, and then tested. The first block tested had 50 per cent. moisture, and its strength had fallen to 1,710 lbs. per sq. inch. Afterwards the process of drying was slower and the interval of time between the tests

was made greater. After 12 weeks the moisture contents were down to 13 or 14 per cent. The relation between the crushing strength of the wood in pounds per sq. inch and the percentage of moisture in the wood, as determined in this way, is shown in

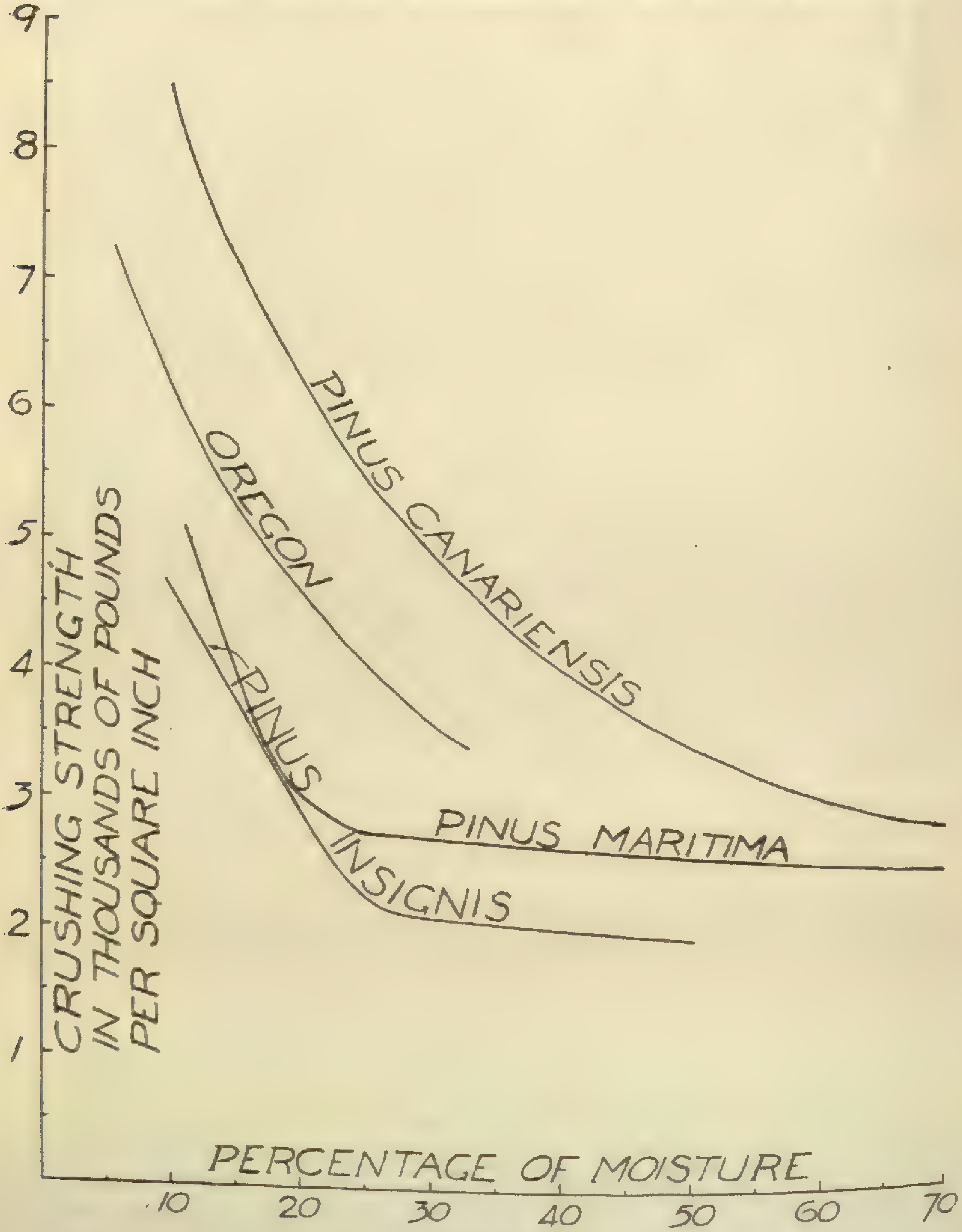

Fig. 1.

the curve for *Pinus insignus* in fig. 1. It was found that the average results of tests made in the ordinary way, as the timber was seasoning, fitted well on the curve thus obtained,

showing that the strength of the wood was the same whether the moisture was obtained from soakage in water or whether it consisted of the natural sap. It will be seen from the curve that the strength in compression falls off very rapidly as the moisture increases above the 10 per cent. or thereabouts contained in well-seasoned wood in this climate, the diminution in strength being practically proportional to the increase in the percentage of moisture until the strength becomes less than half that of well-seasoned wood when the moisture contents amount to 25 per cent. of the dry weight. From this point on the diminution in strength will further increase in moisture is much less marked. With 10 per cent. of moisture the average crushing strength is 4,600 lbs. per sq. inch, at 25 per cent. it has fallen to 2,250, and at 50 per cent. of moisture it is 1,940 lbs. per sq. inch.

Similar sets of tests were made upon blocks of *Pinus maritima*, *Pinus canariensis*, and oregon, with results that are shown upon the curves of fig. 1. The curve for *Pinus maritima* is very similar to that of *Pinus insignis*. At 10 per cent. of moisture it indicates a strength of 5,600 lbs. per sq. inch, and at 25 per cent. a strength of 2,750, a little less than half, while with a further increase of moisture up to 70 per cent. the strength is reduced only to 2,450 lbs.

Wood when placed in water not only increases in weight by absorption but expands in volume. This is a feature that causes much practical difficulty to engineers when using wood blocks for street paving, but the author is not aware of any attempts having been made to measure the force which the wood can exert in this way when prevented from expanding. With this object in view a rectangular block of *Pinus insignus*, $3\frac{3}{4}$ in. × 3 in. and 4 in. high was placed in a flat dish on the compression table of the Riehlé testing machine. The grain was horizontal and the rings as shown in fig. 2. A tightening load of 600 pounds was put upon it, and the block was thus held between two cast iron plates, top and bottom, which could not move, but the upward force on the top plate could be measured at any time by balancing the lever of the machine. Water was then placed in the dish, nearly, but not quite up to the top of the block. This was done at 10 a.m. and gradually throughout the day, as the block absorbed more water, it exerted a greater and greater upward force on the top block. By noon this force was 1,100 lbs., and at 5 p.m. it was 1,520 lbs. It was left all night and next morning it had dropped to 1,360 lbs., and continued to drop slightly throughout the day. Next morning it was down to 1,280 lbs. On removal from the machine it was found that the block exhibited a typical compression failure, as though it had actually

burst itself in the effort to expand. The character of the failure is shown in the second figure (fig. 2). Another similar block of *insignis*, $2\frac{3}{4}$ in. × $3\frac{3}{4}$ in. in area, treated in the same way, gave a maximum load of 1,460 lbs. This also failed in compression. The average maximum pressure exerted by the two blocks was 139 lbs. per sq. in. A block of *Pinus canariensis* was dealt with in the same way, and for three days it was left in the testing machine, and gave a pressure gradually increasing up to 128 lbs. to the sq. in., when it had to be removed to make way for other tests. This block showed no sign of failure.

When the timber was first received small cylinders about 3 in. in diameter and 1 in. long were accurately turned out of the green wood from blocks whose moisture contents had just been determined. These were then weighed and accurately

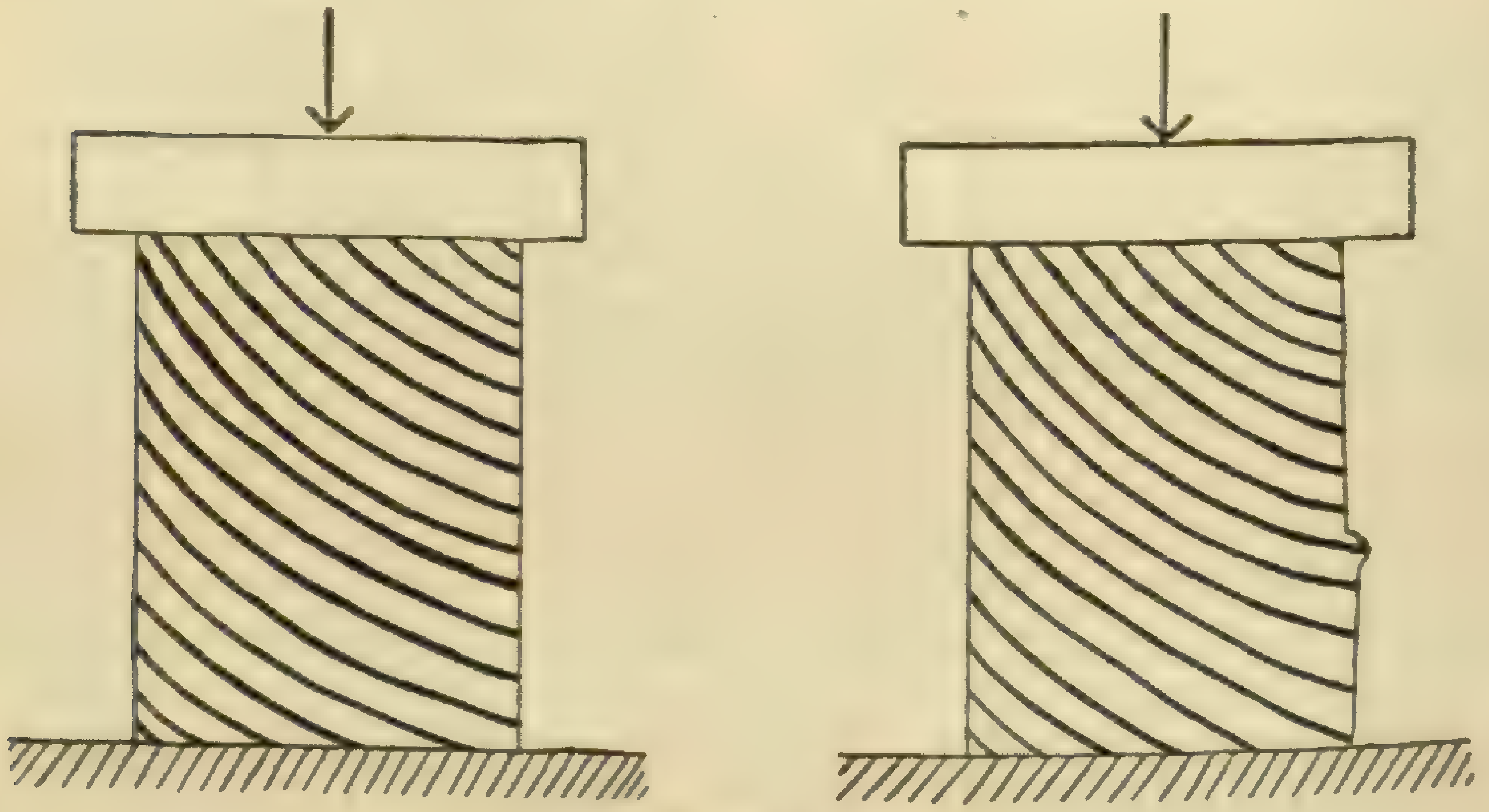

Fig. 2.

measured along marked diameters in directions parallel and perpendicular to the rings. The average measurements in August, 1917, at the end of March, 1918, and in October, 1919, are shown in Table I. It will be seen that by the end of March, 1918, these small pieces had lost all the moisture they were free to lose and at that time of the year showed a percentage of only 7 to 9 per cent. The contraction in the direction parallel to the rings was in all cases greater than that in the perpendicular direction, and was most for *Pinus maritima* and least for *insignis*. For *Pinus maritima* it amounted to 4·8 per cent., which is less than half the contraction that might be expected from a Eucalypt with the same initial quality of moisture. It will be noticed that when measured again in October, this year, the blocks all showed an

TABLE I.

Shrinkage of small cylinders of wood on drying, in directions parallel and perpendicular to the rings.

Timber.	Average Diameters ∥ to Rings.			Average Diameters ⊥ to Rings.			Per cent. Moisture.		Per cent. Decrease on 26/3/18.	
	13/7/17.	26/3/18	7/10/19.	13/7/17.	26/3/18.	7/10/19.	13/7/17.	26/3/18.	∥ to Rings.	⊥ to Rings
Pinus maritima ...	2·994	2·846	2·871	2·9965	2·9315	2·941	80	9·3	4·88	2·09
Pinus canariensis...	3·002	2·890	2·902	3·001	2·937	2·9475	55	8	3·73	2·13
Pinus insignis ... (Mount Burr)	2·994	2·890	2·907	2·996	2·9345	2·952	140	7	3·35	2·04
Pinus insignis ... (Wirrabara)	2·987	2·895	2·913	2·990	2·937	2·947	100	7	3·07	1·77

expansion due to the absorption of moisture from the atmosphere during damp weather.

In order to further investigate the relation between the expansion of the wood and its moisture contents two small cylinders about 3 in. in diameter and 1 in. long were cut from beams of each species. These were measured along marked diameters, parallel and perpendicular to the rings, and weighed. They were then kept immersed in water for two

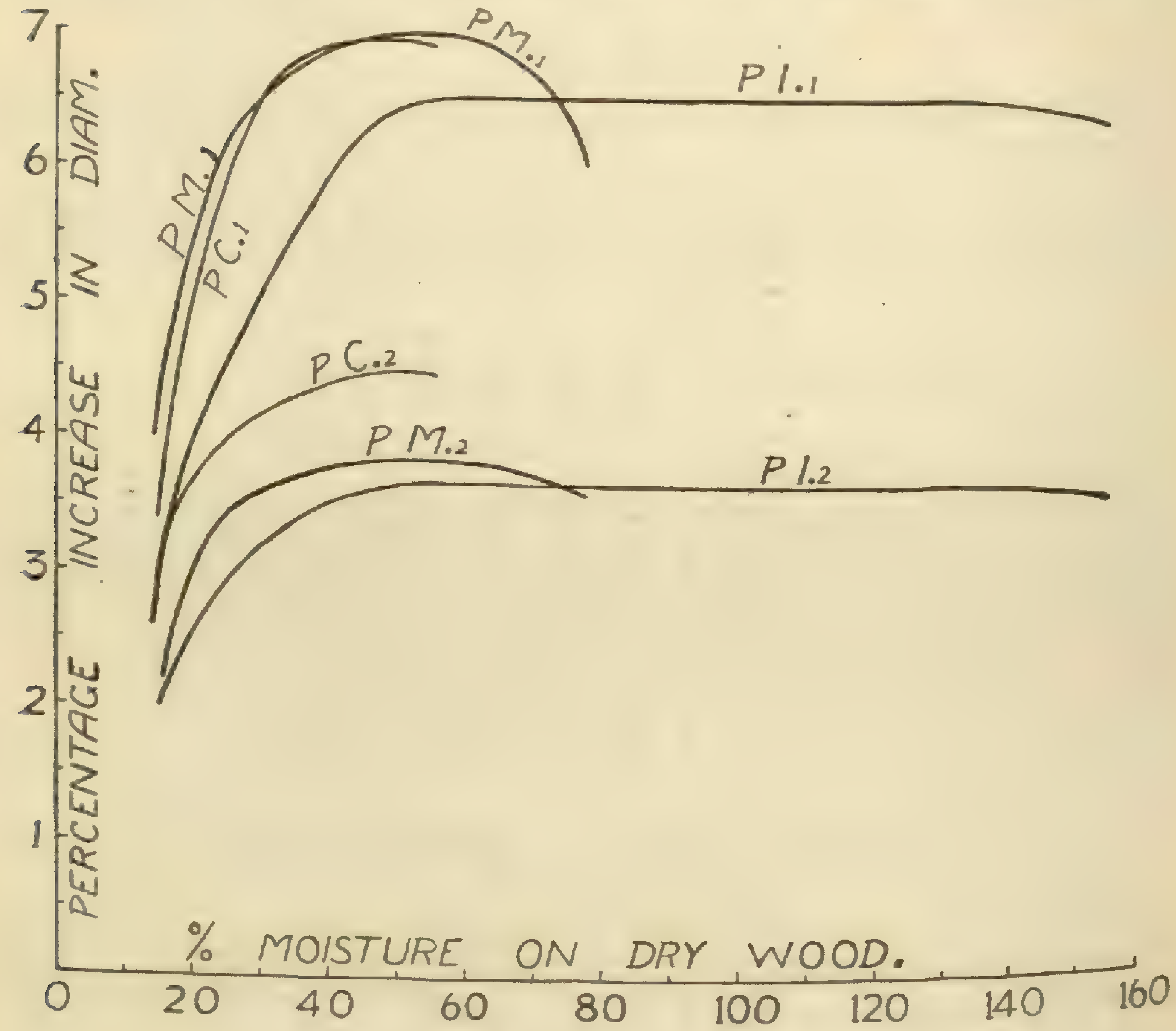

Fig. 3.

Showing contraction of wood on drying after immersion in water.
P.M. refers to *Pinus maritima*. P.I. refers to *Pinus insignis*.
P.C. refers to *Pinus canariensis*.
The suffix 1 indicates the curves showing contraction parallel to the rings.
The suffix 2 indicates the curves showing contraction perpendicular to the rings.

days, after which they were removed and again weighed and measured. It was found that the moisture contents of the *insignis* blocks now amounted to over 150 per cent. of the dry weight of the wood. The *maritima* blocks did not absorb

much more than half as much, their moisture contents being now 78 per cent. The *canariensis* blocks carried only 55 per cent. The blocks were now allowed to dry gradually over a period of about eight weeks and were weighed and measured at intervals. Finally, when they had dried down to less than their original weights when freshly cut out of the beams, they were put in a drying oven and kept at a temperature of a little over 100° C. for seven hours. They were then taken out one by one and rapidly weighed and measured. From this series of measurements the curves shown in fig. 3 have been plotted, showing the relation between the moisture contents, as expressed in percentage of the dry weights, and the diameters expressed as percentages of the diameter of the dry block.

As soon as the blocks were taken out of the water they at once started to dry out and decrease in weight, but, curiously enough, continued to still further expand for a day or two, although they were losing moisture. After that the *insignis* blocks, which had absorbed the greatest quantity of water, remained practically of the same diameter until the moisture contents were reduced to about 50 per cent., as measured on the dry wood, when contraction began to take place. Contraction then took place at an accelerating rate as the wood further dried, and in all cases the greatest amount of contraction for 1 per cent. loss of moisture took place as the wood finally dried down to the 10 or 12 per cent. of moisture that is permanently contained in seasoned timber. This explains why the doors of our houses sometimes stick in the winter. The alteration of the moisture contents of seasoned wood with the humidity of the air only ranges over 2 or 3 per cent., but it occurs just at the point where the rate of contraction or expansion is greatest.

The somewhat remarkable behaviour of the wood under the conditions of the tests seems to be capable of explanation when the fact is taken into consideration that the water in the wood exists partly as free water within the cells and partly as absorbed water in the cell walls. The contraction or expansion of the wood is due to a change in the moisture contents of the cell walls. An alteration of the amount of free water within the cells will of itself produce no effect on the dimensions of the block. The complete saturation of the cell walls evidently takes time and when the *insignis* blocks were first removed from the water, although the cells were full the walls had not yet absorbed quite as much as they were capable of absorbing. The process of saturation of the walls would then still go on, as long as there was free water within the cells, and the blocks in consequence still expanded. After

that the water gradually dried out from within the cells, but, so long as there was any free water at all within the cells, the walls remained saturated and no change consequently took place in the dimensions of the block. The stage shown by the curves of fig. 3 where the *insignis* blocks show no contraction at all as they dry out from about 140 to about 50 per cent. of moisture represents the phase therefore when the free water is drying out from within the cells, but the cell walls are still

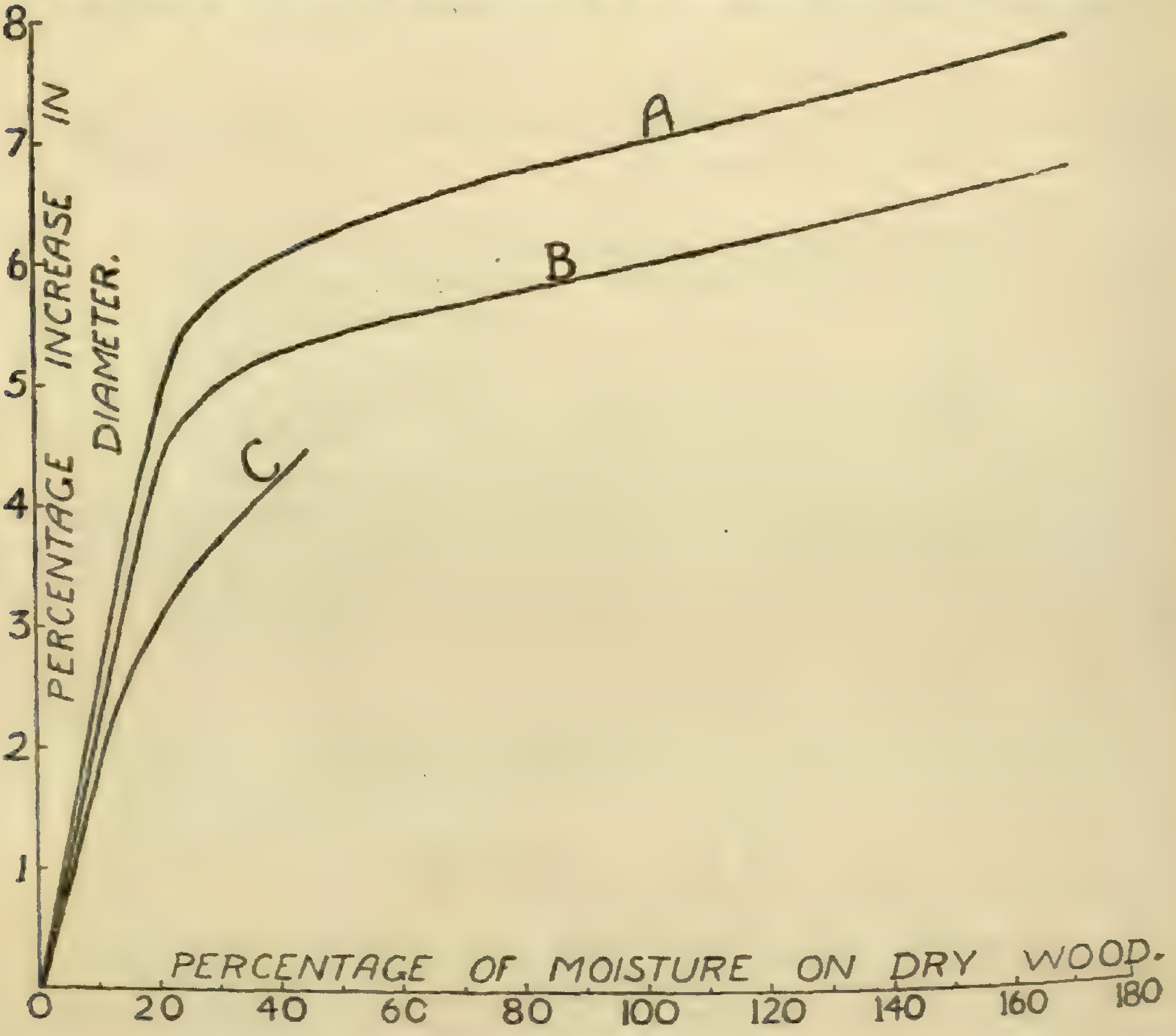

Fig. 4.

Showing expansion with moisture of *Pinus maritima*.
A, sapwood parallel to rings. B, sapwood perpendicular to rings. C, heartwood.

saturated. Beyond that, when the cells have lost all their free water, moisture is then given out by the cell walls and contraction begins to take place, this contraction being much more marked in the direction parallel to the rings than in the radial direction.

The blocks from which the curves of fig. 3 were drawn were cut from near the centre of the tree and contained a

TABLE II.

The numbers in parentheses show the number of tests.

Timber.	Tree from	Beam Tests. f	Beam Tests. E	Beam Tests. Moist. %	Shearing. ⊥ Rings	Shearing. ∥ Rings	Shearing. ∠45° to Rings.	Shearing. Moist. %	Compression. Along the Grain. Strength.	Compression. Along the Grain. Moist %	Compression. Across the Grain. 3 % Deflect	Compression. Across the Grain. 15 % Deflect	Compression. Across the Grain. Moist. %
Pinus insignis ...	Wirrabara Forest .. (Age, 20 years)	6,214 (12)	1,203,282 (11)	11	784·5 (4)	688 (4)	839 (10)	11	4709 (30)	11	1773 (4)	2337 (4)	11
		4,246 (1)	658,000 (1)	100					2257 (2)	100	686 (1)	1045 (1)	100
	Wirrabara Forest ... (Age, 30 years)	6,810 (12)	1,443,267 (12)	11	421 (2)	546 (3)	765 (7)	11	4345 (19)	11	918 (3)	1382 (3)	11
	Mount Burr Forest .. (Age, 33 years)	8,019 (10)	1,415,620 (10)	11	687·5 (2)	900 (2)	925 (6)	11	5264 (6)	11	729 (1)	1029 (1)	140
		4,430	732,000	140					2855 (2)	140			
	Average of Trees ..	6,856 (35)	1,376,211 (34)	11	669 (8)	688 (9)	906 (23)	11	4626 (57)	11	1269 (10)	1618 (10)	12
Pinus maritima	Wirrabara Forest .. (30 years old)	6325 (12)	1,563,958 (12)	11	570 (2)	730 (1)	758 (9)	11	5320 (11)	11	1264 (2)	2134 (2)	11
	Mount Burr Forest ... (33 years old)	3,954 (10)	1,171,440 (10)	11	667 (1)	840 (1)	901 (6)	11	5240 (6)	11	1898 (4)	2583 (3)	11
		4,473 (1)	820,000 (1)	80					3207 (2)	80	744 (1)	1272 (1)	80
		4,700 (1)	586,000 (1)	44					2990 (1)	44			
	Average	5,280 (22)	1,399,677 (22)	11	602 (3)	785 (2)	815 (15)	11	5233 (17)	11	1700 (6)	2407 (5)	17
Pinus canariensis	Bundaleer Forest Reserve	11,724 (10)	1,925,990 (10)	12	832 (1)	1318 (1)	1433 (2)	12	8293 (4)	11	2460 (3)	3280 (3)	14
		7,926 (2)	1,248,500 (2)	62					3420 (3)	65	1422 (1)	2134 (1)	69
Oregon Pine ...		7,322 (13)	1,827,438 (13)	17	481 (4)	407 (4)	—	15	7943 (13)	15	1244 (10)	1425 (9)	15

little heartwood. It became evident that there was a marked difference in the behaviour of the heartwood and sapwood with regard to their powers of absorption, and so tests were made in which blocks were cut out of heartwood and sapwood separately. The result of such tests on *Pinus maritima* are shown in fig. 4. In this case the sapwood blocks absorbed water up to 170 per cent., but under the same conditions the heartwood blocks only absorbed 45 per cent., and the curves indicate that the heartwood cells could hold very little free water.

The combined average results of all the strength tests is given in Table II. The outstanding feature of these is the very great superiority, so far as strength is concerned, of *Pinus canariensis*. In every respect this timber exhibited quite remarkable strength for a soft wood, and although most of the tests upon it were made while it contained 12 per cent. of moisture, as against 11 per cent. for *Pinus insignis* and *Pinus maritima*, it was far stronger in every respect. Both as a beam and in direct compression along the grain its strength is comparable with that of our hardwoods. Thus the average of all the beam tests indicates that a beam 12 in. × 12 in. and 12 ft. long will carry a central load of about 42 tons, if the wood is *canariensis*, before it breaks down. If the wood is *insignis* it will carry 24 tons, if *maritima* 19 tons, and beams of the same size of oregon, of the quality of those tested, would carry 26 tons. The superiority of the *canariensis* both in resistance to shear and in compression is equally well marked. A short column of *canariensis*, 12 in. sq., will carry a load of 533 tons before it actually fails. While a column of the same size of *insignis* will carry only 297 tons, and a column of *maritima* 336 tons. The value of *Pinus canariensis* for all structural purposes is so very great, and so much greater than that of the other pines, that it is eminently desirable in the State interests that it should be extensively planted in our forests.

The following notes on *Pinus canariensis* have been kindly supplied to me by Mr. H. H. Corbin, B.Sc., Lecturer on Forestry at the Adelaide University:—"This pine has been planted in a very diffuse way since the days of the earliest settlement in Australia. The tree, notwithstanding this, has not been appreciated at its correct value by our foresters. The area of Canary pine woods in the whole of Australia is certainly not more than a hundred or two acres. In South Africa it is very extensively planted. It has an erect habit even when growing in the open. It will grow in 20 years about 50 ft., at 35 years it is, under favourable conditions, a tree about 2½ ft. in diameter and 90 ft. high. It will grow in any soil which is not too wet or sandy. It flourishes in the

18-20 in. rainfall areas, but does best in the 20-25 in. rainfall areas on the heavier soils. It develops a tap root as a little one-year-old nursery tree, and if transplanted 'open root' needs shelter from hot winds till established. In pots the tap root invariably coils round in the bottom of the pot and it is very unsatisfactory to plant; many die when treated in this way. The tree is certainly well adapted to planting in proper woods in the drier areas of this State. At Bundaleer it is seen withstanding the long dry summer on rough quartzite rock. It is free from disease. It yields an extraordinary amount of resin and turpentine. The younger trees up to 40 years old if felled coppice, but this is of little economic value. The tree has all the virtues of the *insignis*, but is 15 per cent. slower in its growth. When the drought is killing *insignis* trees the Canary Island pines are thriving. Further, pests do not attack it and fire will not wipe it out, as it sprouts again and continues its growth."

Pinus insignis has been commonly regarded as a rather poor timber, but the results show that its strength compares quite well with that of oregon. It is not quite so good as a beam, though the difference is not very great, but it has a greater resistance to splitting and shearing along the grain, and it is less easily compressed across the grain. It is quite a useful timber for structural purposes. *Pinus maritima* is not so good as *Pinus insignis* as a beam, nor has it so great a resistance to shearing, but its strength in compression is greater than that of *insignis*.

A large amount of work is involved in carrying out such a series of tests, both in the actual experiments and in the numerical reduction. For very considerable help in all this I wish to acknowledge my indebtedness to Mr. H. H. Cartledge, who was till recently my assistant, and also to Messrs. Altmann, Francis, James, and Robin, students in the Engineering School at the University.

MISCELLANEA.

Notes on Occurrences during Summer Recess, 1918-19.

Fellow Members—I was very pleased when the printers forwarded to me, just before the end of 1918, vol. xlii. of the Transactions and Proceedings of the Royal Society of South Australia (Incorporated). It is not so large a volume as we have been compiling during the past four or five years. That we knew would be the case because the Adelaide Museum, the Curators of the different departments of which have supplied us with abundant material in bygone years, now publishes its own Records. This is an event which was bound to arise, which is quite in order, and which we welcome. It is satisfactory to find that, notwithstanding this, our volume appears with 340 pages of letterpress and 32 plates, and its contents embrace quite an interesting variety of subjects and are very well illustrated. If we can maintain a yearly output of this quantity and quality—and it should improve as the years go by—we shall justify our existence, retain our present exchange with other societies, and be contributing our quota to the accumulating scientific knowledge of the world.

May I be allowed now to offer a sheaf of congratulations?

First, we have to congratulate PROFESSOR HOWCHIN on his very valuable work, "The Geology of South Australia," published towards the end of last year. It supplies what has been a recognized want in Australia, a text book for Australian students providing, where possible, local examples and illustrations. His own extensive discoveries in the geology and palaeontology of our State first published in our Transactions, and of world-wide notoriety, have furnished no little part of the material for his text book. We congratulate him further on one result of his effort, namely, the recognition of its merit by the Council of the University of Adelaide, which has conferred on him, in addition to his previous title of Lecturer on Geology and Palaeontology, that of Honorary Professor. We shall have the pleasure for the future of addressing him as Professor Howchin.

We have also to congratulate DR. PULLEINE upon the issue, in collaboration with Mr. Rainbow, of their fine Monograph, "The Australian Trapdoor Spiders." As we well know, he has been working at this subject for several years, and their paper in the Records of the Australian Museum, covering more than 80 quarto pages and illustrated by 13 plates of beautifully executed photographs, is a valuable

addition to the literature of the group, and a result in which they may feel a proper pride and satisfaction. We are pleased to know we may expect the publication by these authors in the same style of excellence of further contributions to the natural history of other groups of Australian Spiders.

We are also glad to offer our felicitations to Mr. W. B. POOLE, who has completed 50 years of service with the Savings Bank of South Australia, in which he rose to the highest office, and who has been now released to pass his remaining days at leisure. It has been our good fortune for nine or ten years to have had him as our Honorary Treasurer after being, as we may say, specially trained for us as an expert in finance. We trust he will enjoy for many years this responsible, but happily not very onerous post, and so free the Society from all anxiety about its accounts, and we wish him full enjoyment not only of this useful service, but of his freedom from the ties and worries of the large State business concern, the present proportions of which must in measure be credited to him.

We will also take this opportunity of referring with pleasure to the safe voyage of MR. EDWIN ASHBY across somewhat perilous seas to and from America, and to the title which has been conferred upon him of C.F.A.O.U. (Corresponding Fellow of the American Ornithological Union) in recognition of the work he has done in connection with Australian birds.

But we have also the sad duty of referring to the decease of two of our Fellows.(1)

MISS ELLEN MILNE BUNDEY, the daughter of Sir W. H. Bundey, formerly one of our Judges, was elected a Fellow of our Society in 1906. She had the unique distinction of being our only lady Fellow. Her tastes were literary and musical rather than scientific, and as Lyell Dunne she occasionally contributed verses to the daily Press, and under the stress of an intense patriotism strove to assist various organizations in the same way. She was a Bachelor of Music of our University since 1900. Through ill-health she has been debarred from attendance at our meetings, but has always taken a keen interest in the work of the Society, and appreciated its records in our Transactions. Her interest is practically shown by a gift to our Library of sixteen volumes of Lloyd's Natural History.

JOS. C. VERCO, President.

Evening Meeting, April 10, 1919.

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(1) An obituary notice of the late Sir Edward C. Stirling will be found on page 1 of this volume.—ED.

The Amethystine Colouration produced in Glass by Ultra-violet and X-Ray Radiation.

The amethystine colouration of bottles from the Far North of South Australia, where they have been exposed to sunlight, has upon several occasions been brought to the notice of the Society.

In these cases, the colouration was presumably caused by solar ultra-violet radiation. The tabled exhibit showed a similar colouration produced in glass owing to bombardment by X-rays produced by the "Coolidge" Electron type of X-ray tube.

In the walls of the "Coolidge" tube itself, the colouration is very beautifully shown, unless masked by a deposit of tungsten, caused by volatilization at the focal spot, due to excessive energy imputs. In the old gas tubes, it was similarly masked, where present, owing to the deposit of tiny particles of platinum torn from the target by the bombardment of cathode rays.

Reference was made to various work relative to the subject, including that of Dr. M. Luckiesh, of the Nela Research Laboratory, who possessed samples of glass showing a bluish tinge in the case of potash and a yellowish-green tint in the case of sodium glass, produced by exposure to solar radiation. A sample of lead glass exhibited a muddy yellow colour after exposure to X-rays.

The purplish colour is assumed to be due to a change in the chemical or physical state of the manganese contained in the glass. The colouration is quite unstable, and disappears upon the application of heat. There appears to be no agreement as to whether the manganese is present as in solution, or in the colloidal form.

The effect when brought about by solar radiation is supposedly due entirely to the ultra-violet rays. In manganese glass used in connection with electric lighting, the colour has only been observed where the electric source of light is very rich in ultra-violet rays, such as in a powerful arc.

The big variation in wave lengths of the ultra-violet and the X-rays, which are roughly of the order of 10^{-5} cms, and 10^{-8} cms., respectively, is an interesting consideration, in view of the similarity of effects on the manganese constituents of the glass.

Why the effect apparently ceases so abruptly when the wave lengths pass from the ultra-violet to the visible radiation is a point also worthy of investigation.

A. R. Riddle.

Evening Meeting, August 14, 1919.

ABSTRACT OF PROCEEDINGS

OF THE

Royal Society of South Australia

(Incorporated)

FOR 1918-19.

ORDINARY MEETING, NOVEMBER 14, 1918.

THE PRESIDENT (J. C. Verco, M.D., F.R.C.S.) in the chair.

NOMINATION.—The Rev. D. T. Whalley as a Fellow.

THE PRESIDENT made the following appreciative remarks about the late Dr. W. L. Cleland:—

"It is only fitting that we should make more than a passing reference to the death during the past month of Dr. W. L. Cleland, who for thirty-seven years was a Fellow of our Society. He was elected a member in 1879, just at the time the Adelaide Philosophical Association was converted into the Royal Society of South Australia. In 1882 he accepted the very onerous position of Hon. Secretary, which he retained for fifteen years. When we recall that during six of those years he was also Hon. Secretary to the South Australian Branch of the British Medical Association and also to the Medical Benevolent Association of South Australia, one begins to realize what a mass of work he carried out in his quiet, unostentatious way. He only received his deserts when on transferring the Secretariat of the Royal Society to Mr. G. G. Mayo he was granted the highest honour we could confer and was elected President, in which office he served for two years. He fulfilled it with the same assiduity and reliability as in his more humble post. for the Minutes show that on only two occasions during the Presidency was he absent from his official chair. When he retired from this he was for two years in succession chosen Vice-President, and after that a member of the Council, a sure sign of his reliability and worth.

"In 1887 he read a short paper describing the geological features of the country about the head of Lake Gilles, where were some polished rock surfaces.

"In 1899 his Presidential address dealt with the aboriginals of Australia, while that of 1900 was in extension

of the same subject, on 'Factors producing Uniformity of Type amongst Australian Aboriginals,' illustrated by photographs of the natives from various districts in our continent.

"When we review his association with our Society we cannot but pay very cordial and eulogistic tribute to his memory as one of our most helpful and efficient Fellows."

Exhibits.—Mr. Walter Howchin exhibited a large cylinder of flint obtained by Mrs. Pascoe of Port MacDonnell from the flint-pebbles deposit, situated on the beach about five miles to the westward of Port MacDonnell. The specimen measures 26 inches in height and 55 inches in circumference. It has a certain superficial resemblance to a fossil tree, but as it was formed by segregation in a marine bed and consists of small marine organisms that have become silicified by infiltration, the idea of a fossil tree cannot be entertained. The flint that occurs in the MacDonnell Bay is interbedded with the lower marine Tertiary beds, and is often of abnormal size and shape, some further examples of which were exhibited by Mr. Howchin at the same time. Mr. Edgar R. Waite exhibited a snake obtained by Messrs. Edgar Savage and F. Angel, at Moolooloo, on the Great Northern railway line. It proved to be an example of *Denisonia suta*, Peters, and is, perhaps, only the third specimen recorded under this name, the type being in Berlin, and a second example in the British Museum. All are from South Australia. He also drew attention to the general similarity of *D. frontalis*, Ogilby, and *D. forresti*, Boulenger, to the snake exhibited. He also showed photographs of the large blue whale, 87 ft. 10 in. long, stranded at Corvisart Bay, and later towed to Streaky Bay, where the skeleton was obtained for transmission to the South Australian Museum. Samples of the raw oil were likewise exhibited. Capt. S. A. White exhibited eggs of the wedge-tailed eagle (*Uroaetus audax*), showing great variations in markings and colouration; also eggs of the letter-winged kite (*Elanus scriptus*), taken on the Diamantina River, Western Queensland, by Mr. S. W. Jackson, for Mr. H. L. White, of Scone, New South Wales. In Gould's Handbook of Australian Birds, vol. i., p. 55, the author stated:—"Capt. Sturt obtained it at the Depôt, and Mr. White, of the Reedbeds, South Australia [Capt. White's father], informs me that he found this species in great numbers on Cooper Creek, between latitudes 27° and 28° in 1863. They were always in companies of ten to twenty or thirty." Mr. A. M. Lea exhibited some gall insects of the genus *Brachyscelis*: the female insect is wingless and is enclosed within a gall with three long horns; the male insect on maturity is winged, but in its earlier stages

is enclosed within a much smaller gall than that of the female. He also exhibited some Canadian wonder beans that had been destroyed by a root-eating mite (*Rhizoglyphus echinopus*). Beans and peas are often prevented from growing by these mites, which occur in the soil in countless thousands. Mr. S. DIXON stated that the grass shown by him on September 12 proved to be an importation from South Africa, *Ehrharta villosa*, var. *maxima*. Mr. W. J. KIMBER showed several fossils and fossil casts from Port Willunga. Mr. F. R. ZIETZ, on behalf of the South Australian Museum, exhibited a specimen of the Wilson or yellow-webbed storm petrel (*Oceanites oceanicus exasperatus*), picked up dead on the beach at Port Elliot. Although this bird is said to be numerous out at sea, it is rarely seen close inshore. Mr. A. R. RIDDLE showed electrical apparatus recently imported for the Keswick Military Hospital for enabling radiographs to be taken with very short exposures, thus eliminating any indistinctness from motion due to the action of the heart or lungs.

FLINDERS CHASE.—Capt. S. A. WHITE reported that a strong effort had been made to secure the passage of a Bill for the reservation of Flinders Chase, and that although it could not be carried through this session, he had no doubt of its becoming law in the next.

PAPER.—"Vitality of Seeds," by ALF. G. EDQUIST.

ORDINARY MEETING, APRIL 10, 1919.

THE PRESIDENT (J. C. Verco, M.D., F.R.C.S.) in the chair.

NOMINATIONS.—Edward Charles Grigson and O. A. Glastonbury as Fellows.

ELECTION.—Rev. D. T. Whalley as Fellow.

THE ADVISORY COUNCIL of Science and Industry wrote that their publication, "The Australian Environment," by Dr. Griffith Taylor, could be purchased for 5s., or the set of contour and rainfall maps of Australia separately for 1s. 6d.

THE PRESIDENT referred to the death of Sir Edward C. Stirling and other events which had occurred during the recess. (*Vide* page 1 and MISCELLANEA.)

FLINDERS CHASE.—Capt. S. A. WHITE reported as follows:—"Years ago the Fauna and Flora Protection Committee of our Field Naturalists' Section wisely decided that a reserve was necessary to enable the perpetuation of the country's fast diminishing fauna and flora, especially the former, and steps were taken to have set aside for the purpose a portion of Kangaroo Island. The late Hon. T. Price,

when Premier, approved of the proposal, and the western end of the island was reserved, but it was never legally constituted. In due course, however, a Bill was prepared with that end in view, but, for one reason or another, it was not developed, although Government after Government promised to carry it through. Last year a committee of three—Messrs. S. Dixon and J. M. Black and myself—was appointed by the Royal Society, and an application was made for the reservation of 1,000 square miles of country, toward the preparation of which two prominent citizens had promised to contribute £4,000. Death, unhappily, removed those two public-spirited gentlemen before their offer could be accepted, but the Hon. John Lewis, M.L.C., said he would fence the area. Owing mainly, it is understood, to the great extent of the area specified, strong opposition was offered to the scheme by some of the residents on the island, and eventually a special meeting of the District Council was held at Kingscote, and was attended by Mr. Laffer, M.P., one of the Parliamentary members for the district, and myself. The subject was thoroughly discussed in all its aspects, and finally the Council agreed not to offer any further opposition, a fact which was subsequently conveyed to the Premier (Hon. A. H. Peake), together with an intimation favouring the carrying out of the project. All that remains to make the long-desired Flinders Chase a reality is for the Bill already prepared to be brought up to date and to receive the sanction of Parliament, which, no doubt, will provide for the appointment of a Board of Governors to control the property. The area involved is approximately 200 square miles, west of a line from Cape Forbin on the north, to the Rocky River, round the Rocky River freehold, and thence south-west to the sea."

Exhibits.—Prof. Osborn exhibited specimens of diseased cabbages from a market garden at Piccadilly affected by "black leg." This disease is caused by a fungus, *Phoma Lingam* (Tode), Desmaz. The symptoms commonly observed are a wilt of the tops of certain plants representing from a few to 50 per cent. or more of the crop. The wilted plants are found to have their tap-roots destroyed and somewhat blackened. The fructifications of the fungus are observed as minute black spots around the diseased portions. The fungus also attacks the leaves and stems, flower stalks, and fruit pods. It has recently been shown by Henderson, working at Wisconsin, U.S.A. (Phytopathology, viii., pp. 379-431, 1918), that seed in the pod below such diseased areas is also infected, and will produce infected seedlings. Ample evidence of seed-bed infection was found at Piccadilly. An account of preventive measures was given. He also exhibited shells of

the common cockle *(Chiones scalarina)* on which *Cladophora*, sp., was growing. The shells were collected near the mouth of the American River, Kangaroo Island, from a large area of clean tide-scoured sand. The alga was only found on living shells or those of recently-dead fish, and only growing healthily in the former case. Live cockles are the only objects to which the *Cladophora* can fix itself in this area. The alga was always fixed at the posterior end near to the dorsal hinge. This is the portion of the shell nearest the surface of the sand, but it is also near the exhalent syphon. The suggestion was offered that the alga might benefit by such proximity to the current of water leaving the animal, which would be richer in carbon-dioxide from its passage over the gills of the animal and in nitrogenous material voided into the cloacal cavity. Mr. Edwin Ashby showed some Jonathan apples, which were clean when gathered, but had after a time become spotted with "bitter pit"; also the following birds:—*Phaps chalcoptera*, Lath. (Bronzewing Pigeon); *Cosmopelia elegans neglecta*, Mat. (Brush Bronzewing), from Karoonda; *Hypotaenidia philippensis australis*, Pel. (Eastern Buff-banded Rail); *Porzanoidea plumbea immaculata*, Swain. (Eastern Spotless Crake); *Porzana fluminea whitei*, Mat. (Southern Spotted Crake), from near Paradise, 19/12/18, where the two preceding species and *Zapornia pusilla palustris*, Gld. (Eastern Little Crake), have this season been very numerous, also from a waterhole in the mallee, near Karoonda; *Myzantha melanotis*, Wilson (Black-eared Minah); *Gliciphila albifrons incerta*, Mat. (Eastern White-fronted Honey-eater); *C. melanops chandleri*, Mat. (Tawny-crowned Honey-eater)—the latter for the last few weeks has been singing or whistling freely at Blackwood. Mr. A. M. Lea exhibited a so-called hermaphrodite butterfly, *Delias mysis*, from North Queensland, its right side having the typical markings of a male, and its left side those of a female; normal specimens were shown for comparison. Mr. A. G. Edquist showed a beetle, the abdomen of which was merely an empty skin. It had refused to feed, and had soon died. Mr. F. R. Zietz exhibited a complete set of Australian Falcons, *viz.*, *Falco longipennis* (Little Falcon), *F. hypoleucus* (Grey Falcon), *Rhynochodon peregrinus* (Black-cheeked Falcon), and *Notofalco subniger* (Black Falcon). Mr. E. R. Waite showed a plate of baleen (whalebone) from the blue whale in the South Australian Museum; also the jaw of a small-toothed whale. Mr. W. J. Kimber showed a fish *(Pegasus)* from Port Lincoln, and various fossil shells from Port Willunga and Troubridge for identification. The President showed a volume of newspaper cuttings (one of a

set of 120) containing one referring to the boyhood of John Gould, the ornithologist.

PAPER. — Prof. OSBORN laid on the table and briefly described a paper, "Australian Fungi: Notes and Descriptions, No. 2," by J. B. CLELAND, M.D., and EDWIN CHEEL.

ORDINARY MEETING, MAY 8, 1919.

THE PRESIDENT (J. C. Verco, M.D., F.R.C.S.) in the chair.

ELECTIONS.—O. A. Glastonbury and Edward Charles Grigson as Fellows.

THE PRESIDENT referred with congratulations to the distinction which had been conferred upon our Fellow, Dr. Chas. Fenner, F.G.S., namely, the Sachse Gold Medal, as a recognition of the merit of his paper, read last year before the Royal Society of Victoria, on the "Geology and Physiography of the Werribee River Basin." He also expressed regret at the decease of Mr. E. H. Wainwright, B.Sc. (Lond.), who had been a Fellow of the Society for thirty-six years. He was in former days a teacher of chemistry at the Collegiate School of St. Peters.

EXHIBITS.—Prof. HOWCHIN exhibited a whale barnacle that was picked up by Professor Rennie at Encounter Bay. The barnacles are an abnormal group of the crustacea classed as the Cirripedia. The best-known families in this group are the Lepadidae, or "goose barnacles," and the Balanidae, or "acorn barnacles." The former are attached by a fleshy stalk, and obtained their popular name from the old-world notion that they turned into geese. The Balanidae, or "acorn barnacles," have a cup-like shell, and are sessile, and the typical genus, *Balanus*, is the common form that covers ship bottoms and almost all objects in shallow water. The specimen shown belonged to the Balanidae, and could be referred to the genus *Coronula*, and was probably *C. diadema*. It differs from *Balanus* in that while the latter has a simple turreted shell, in the *Coronula* the inner wall of the shell is deeply infolded, by which the lower part of the shell is divided up into radial chambers. It has the habit of attaching itself to whales, and on that account is known as the whale barnacle. Mr. EDWIN ASHBY exhibited Humming Birds from America, and gave notice of motion for the July meeting as follows:—"That this Society supports the endeavours of the Ornithological Association of South Australia to secure the introduction into Australia of the Humming Birds of America." Capt. WHITE showed two specimens of Sparrow-Hawk (*Accipiter cirrocephalus*), showing the great change in colouration and colour pattern which

takes place in the mature bird; also two specimens of Australian Goshawk *(Urospiza fasciata)* showing the same change. Mr. A. M. LEA exhibited a drawer containing some insects whose sexes are strikingly different in general appearance; in some cases the males are provided with large wings, whilst the females are wingless, or almost so; in others the males are considerably smaller and differently coloured from their females, or are provided with processes on the head that are absent from the females.

FLINDERS CHASE.—Capt. S. A. WHITE reported on the progress made towards the reservation of Flinders Chase.

PAPERS.—"Additions to the Flora of South Australia, No. 15," by J. M. BLACK; and "A Review of the Genus *Loricella* (Order Polyplacophora) with Notes on Features previously unnoted and Description of a New Species," by EDWIN ASHBY, F.L.S., M.B.O.U.

ORDINARY MEETING, JUNE 12, 1919.

THE PRESIDENT (Sir Joseph Verco, M.D., F.R.C.S.) in the chair.

Prof. E. H. RENNIE, M.A., D.Sc., F.C.S., Vice-President, referred to the honour of knighthood recently conferred upon the President, and to the fact that he had been a Fellow of the Society for forty-one years and President continuously for seventeen years, during which time he had rendered the Society valuable service, both personal and financial. He moved—"That this Society offers to Dr. Verco its heartiest congratulations upon the receipt by him of the honour of knighthood." Lieut.-Col. R. S. ROGERS, M.A., M.D., Vice-President, seconded the motion, which was carried by acclamation. SIR JOSEPH VERCO suitably responded.

Prof. WALTER HOWCHIN, F.G.S., laid on the table a progress report of the Australasian Association for the Advancement of Science. The biennial meetings, suspended during the war, would now be resumed, the next being held in January at Hobart.

NOMINATION.—Miss Helen M. Mayo, M.B., B.Sc., was nominated as Fellow.

THE PRESIDENT laid on the table correspondence referring to the suggested establishment in Australia of a National Research Council in affiliation with the International Research Council recently inaugurated. In this connection the Royal Society of New South Wales proposed a conference in Sydney in July. Resolved—"That the Hon. Secretary reply that the Society saw objections in the way of fixing an early date for the Conference, owing to the dislocation of travelling facilities through the coal strike and the influenza

epidemic, especially as it would be too late in any case to send representatives from such Conference to the General Conference at Brussels. If, however, an early meeting is considered advisable, it would be well to fix a date when all or most of the Universities would be in recess. So soon as the exact date is fixed, the Council would appoint delegates."

EXHIBITS.—Dr. PULLEINE exhibited a new species of trap-door spider, genus *Aganippe*, and nests of same, from the banks of the American River, Kangaroo Island, just above high water; also portions of the bird-catching plant *Pisonia Brunoneana*. Mr. A. M. LEA showed a drawer of British beetles, including many which occur in nests of ants.

PAPER.—"Geological Memoranda" (first contribution), by Prof. WALTER HOWCHIN, F.G.S.

ORDINARY MEETING, JULY 11, 1919.

Prof. E. H. RENNIE, M.A., D.Sc., F.C.S. (Vice-President), in the chair.

ELECTION.—Helen M. Mayo, M.B., B.Sc., was elected a Fellow.

INTERNATIONAL RESEARCH COUNCIL.—The conference at Sydney having been fixed for August 20, the appointment of two delegates was left to the Council.

EXHIBITS.—Prof. CHAPMAN showed results of experiments upon the pressure exerted by wood blocks by expansion when soaked in water. Mr. A. M. LEA exhibited some olives thickly covered with black scale insects (*Aspidiotus rossi*) which cause a serious diminution in the yield of oil, besides injuring the tree by attacking the leaves and twigs; also a rust fungus, received from Mr. Henry Greenfield, of Bugle Ranges, from Purple Downs Station, near Port Augusta. This was afterwards identified by Mr. J. M. Black as *Salsola kali* (Family Chenopodiaceae). Mr. EDGAR R. WAITE exhibited photograph of a native of Lihir Island which he had taken during the Museum Expedition last year; also the skull of a native from the island, presented to the Museum by Captain G. W. Mostyn. Both the photograph and the skull were shown to illustrate a practice of the natives of this island which lies off New Ireland in about 3° S. latitude. Shortly after a baby is born the bone of the forehead is either broken with a sharp stone or cut with an obsidian knife, the result being the production of permanent deep vertical grooves; the photograph of the living girl shows two, and the skull four such grooves. He likewise exhibited the skull of a native of New Britain obtained by the late Dr. A. C. Magarey. In this specimen the third molar, or wisdom tooth, instead of appearing in normal position, had erupted towards the angle

of the jaw. Another skull from the same source, showing remarkable sutural development, was also exhibited. Attention was also directed to two artificially distorted skulls from Southern New Britain—a tight wrapping around an infant's head induces an elongated skull. In one of the exhibits the supraorbital region had been included in the wrapping and the ridges had not developed in consequence; in the second head the eyebrows had not been included in the wrapping, and the supraorbital bones had therefore grown to more normal condition. Capt. S. A. White showed ten specimens of *Platycercus*. Two were from the type locality of *P. elegans fleuriensis*, Ashby, one being the typical dark red of the old birds, the other a light phase. Two from Myponga, a few miles north of the above locality, have been classed as *P. elegans adelaidensis*, one being in the green immature plumage. Two from the Adelaide plains are very bright birds. One from Mount Pleasant is also a very bright bird. One from South Para is much lighter. Two from Mount Remarkable are of a decided pale form, and have been looked upon by some ornithologists as being more closely allied to *Platycercus flaveolus* than to *P. elegans adelaidensis;* with this he did not agree, for to his mind this form partakes more of *adelaidensis* than *flaveolus*. He also showed a stone from slate outcrops at Mount Remarkable, ripple marked, showing that it had been deposited in shallow water. Mr. F. R. Zietz showed a pink-eared duck *(Malacorhyncus membranaceus)* from the Lower Murray. Mr. E. Ashby showed a pyrites concretion from the Tapley Hill slate.

Papers.—"Notes on the Occurrence of Aboriginal Remains below Marine Deposits at the Reedbeds, Fulham, near Adelaide, by S. A. White, C.M.B.O.U.; "Supplementary Notes on the same, with Remarks on the Geological Section," by Prof. Walter Howchin, F.G.S.; "A New Species of *Aganippe* from Kangaroo Island, with Notes on the Distribution of the Genus in Australia," by R. H. Pulleine, M.B.; "Notes on Australian Polyplacophora, including descriptions of two new genera, a new variety, and the description and proposed recognition of W. T. Bednall's *Stenochiton pilsbryanus*," by Edwin Ashby, F.L.S., M.B.O.U., etc.; and "The Occurrence and Origin of certain Quartz-Tourmaline Nodules in the Granite of Cape Willoughby," by C. E. Tilley, B.Sc. (communicated by Prof. Howchin).

Ordinary Meeting, August 15, 1919.

The President (Sir Joseph Verco, M.D., F.R.C.S.) in the chair.

Letter received from the INTERNATIONAL RESEARCH COUNCIL, enclosing Agenda of the Conferenec to be held in Brussels on July 18, 1919; also letter from the Royal Society of New South Wales *re* Conference to be held in Sydney on 21st inst. Resolved—"That our Hon. Fellows, Professor David and R. Etheridge, jun., be asked to represent this Society at the Sydney Conference, or, in case of their not being able to do so, then our Hon. Fellows Charles Hedley and Professor Wilson."

PAPERS.—"A Contribution to the Study of Habronemiasis," by LIONEL B. BULL, D.V.Sc. A paper on "The Phaestos Disk: its Cypriote Origin," by ALAN ROWE (communicated through the President), was laid on the table, and its reading was postponed until the next meeting.

ORDINARY MEETING, SEPTEMBER 12, 1919.

THE PRESIDENT (Sir Joseph Verco, M.D., F.R.C.S.) in the chair.

NOMINATIONS.—Prof. T. Braileford Robertson and Alan Rowe were nominated as Fellows.

EXHIBITS.—Prof. WALTER HOWCHIN exhibited a tympanic (ear) bone of a whale obtained from the Abattoirs bore, near Dry Creek, about 400 feet from the surface. The specimen probably belongs to the genus *Balaena*, or the Right Whales, as they are known by whalers, and most likely formed part of an immature individual of *Balaena australis*, one of the chief specific representatives of the Balaenidae in the Southern Hemisphere. The bed from which it was obtained is of Upper Pliocene Age. Remains of the Balaenidae are very common in beds of similar age in England and on the Continent of Europe. Fragments of another example were also obtained from the same bore. Capt. S. A. WHITE showed remains of oranges from Fulham, near Adelaide, from which the whole of the pulp and pith had been extracted by black rats, leaving only the rind. Mr. A. M. LEA exhibited a gigantic longicorn beetle *(Batocera wallacei)* from New Guinea, measuring 18 inches across the extended antennae. Mr. A. R. RIDDLE showed a glass-headed pin in which the glass had assumed an amethystine tint from exposure to X-rays. (*Vide* MISCELLANEA.)

PAPERS.—"The Phaestos Disk: its Cypriote Origin," by ALAN ROWE (communicated by the President); "Australian Coleoptera, Part I.," by ALBERT H. ELSTON, F.E.S.; "The Petrology of the Granitic Mass of Cape Willoughby, Kangaroo Island, Part I.," by C. E. TILLEY, B.Sc. (communicated by Prof. Walter Howchin); "Notes on some Miscellaneous Coleoptera, with Descriptions of New Species, Part V.," by

ARTHUR M. LEA, F.E.S., and "Australian Fungi: Notes and Descriptions, No. 3," by J. B. CLELAND, M.D., and EDWIN CHEEL.

ANNUAL MEETING, OCTOBER 9, 1919.

THE PRESIDENT (Sir Joseph Verco, M.D., F.R.C.S.) in the chair.

ELECTION.—Professor T. Brailsford Robertson and Alan Rowe were elected Fellows.

The Annual Report and Balance-sheet were read and adopted.

ELECTION OF OFFICERS.—The following were elected for the year 1919-20:—*President*, Sir Joseph Verco, M.D., F.R.C.S.; *Vice-Presidents*, Major R. H. Pulleine, M.B., and Edwin Ashby, F.L.S., M.B.O.U.; *Hon. Treasurer*, W. B. Poole; *Members of Council*, Professor E. H. Rennie, M.A., D.Sc., F.C.S., Lieut.-Colonel R. S. Rogers, M.A., M.D., Professor Walter Howchin, F.G.S., Professor R. W. Chapman, M.A., B.C.E., F.R.A.S., and Captain S. A. White, C.M.B.O.U.; and the resignation of Samuel Dixon was accepted; *Auditors*, W. L. Ware and Howard Whitbread; *Representative Governor* on Board of Public Library, etc., Professor Walter Howchin, F.G.S.

Resolutions were passed recording the Society's appreciation of the service renderd by Capt. S. A. White in obtaining the passage through Parliament of the Flinders Chase Bill, and also of the long service of Mr. Samuel Dixon as a member of the Council, with special reference to his exertions in connection with the reservation of Flinders Chase.

EXHIBITS.—Mr. E. ASHBY exhibited three plants from Kangaroo Island—an Aster, an Eriostemon, and *Prostanthera speciosa;* also a fungus, commonly known as "native bread," from Gippsland, which, after being brought to Balaklava had grown mushroom-shaped protuberances which would apparently become spore-bearing. Mr. A. M. LEA showed some night-feeding caterpillars (cut-worms) from Bordertown, where on one farm similar caterpillars had completely destroyed 12 acres of wheat; other parts of South Australia had also been badly affected. He also showed some predaceous water bugs *(Dyplonychus)*, the females of which lay their eggs on the backs of the males; they were obtained at Murray Bridge by Mr. H. Hale. Mr. W. H. SELWAY showed a granite erratic from Inman River, showing signs of glaciation; also a chalcedonous nodule from north of Marree. Mr. B. S. ROACH, on behalf of Mr. Lipson Hancock, showed and presented to the Society three enlarged photographs of aborigines taken at Ooldea, on the Port Augusta-Kalgoorlie railway.

PAPERS.—"Notes on Three Species of Melaleuca," by EDWIN CHEEL (communicated by J. M. Black); "A Revision of the Australian Salicornieae," by J. M. BLACK; "Description of Six New Species of Australian Polyplacophora," by EDWIN ASHBY, F.L.S., M.B.O.U.; "Additions to the Flora of South Australia, No. 16," by J. M. BLACK; "The Physical Properties of Some South Australian-grown Pines," by Prof. R. W. CHAPMAN, M.A., B.C.E., F.R.A.S.; and "The Cambrian Trilobites of Australia and Tasmania," by R. ETHERIDGE, jun.

ANNUAL REPORT, 1918-19.

The Annual Volume of the Society's Transactions will this year comprise papers dealing with a more varied selection of subjects than usual. While Australian Fungi are further dealt with by Dr. J. B. Cleland and Mr. Cheel, and various other branches of natural history and geology by Professors Howchin and Chapman, Dr. Pulleine, and Messrs. Ashby, Black, Cheel, Elston, Etheridge, Lea, and Tilley, Dr. Bull contributes an interesting paper on a veterinary pathological subject, Mr. Rowe a discussion of a matter of great archaeological interest, and Captain White and Professor Howchin a description of the discovery near Adelaide of aboriginal remains of considerable antiquity.

The interest of the evening meetings has been maintained by the varied exhibits shown by members.

Steps are being taken to reorganize the regular exchange of our publications with those of other scientific bodies, many of which have fallen into arrear owing to the difficulty of transit during the war.

In October, 1918, an International Conference of Scientific Associations was held in the rooms of the Royal Society of London, and attended by delegates from all the allied countries, with a view to establishing an International Research Council for the promotion of scientific research and the dissemination of the results throughout the affiliated organizations. A further meeting was held in Paris in November, 1918, when the movement was definitely launched. This and other scientific societies of Australia have been invited to form an Australian branch, and a conference to consider the proposal was held in Sydney last August, and was attended by representatives from this Society. It is hoped that the result will be our affiliation with what will eventually

become a world-wide organization for the extension and dissemination of science.

The long sought dedication of the western portion of Kangaroo Island as a reserve for the conservation of our fauna and flora will soon be an accomplished fact, the Flinders Chase Bill having passed both houses of Parliament, and now only awaiting the vice-regal assent.(1) As this Society and the University of Adelaide are each to be represented upon the board of control, there is every reason to hope that, although the area reserved is smaller than was desired, the best use will be made of the land for the fulfilment of the objects aimed at. The success of the thirteen years' campaign by this Society is very largely due to the continued work of three of our Fellows: Mr. Ashby, Mr. Dixon, and Captain White, the last especially having been untiring in his efforts to ensure the passage of the Bill through Parliament.

The President of the Society having been created a Knight Bachelor, the Fellows took the first opportunity to offer to Sir Joseph Verco their hearty congratulations upon the honour conferred upon him by His Majesty.

The Endowment Fund has been augmented by a donation of £100 from Mrs. Ellen Peterswald. The claims of this fund are urged upon those who are able by their contributions to enlarge the usefulness of the Society.

There have been several losses from our Fellowship by deaths, including that of Sir Edward C. Stirling, a notice of whose valuable work in the service of science will appear in our annual volume.

The present membership of the Society is 10 Honorary Fellows, 5 Corresponding Members, 75 Fellows, and 1 Associate.

JOS. C. VERCO, *President*.

WALTER RUTT, *Hon. Secretary*.

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(1) The Bill has since received the endorsement of His Excellency the Governor and become law.—ED.

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED).

Revenue and Expenditure for 1918-19.

	£	s.	d.	£	s.	d.
To Balance October 1, 1918				391	11	6
,, Subscriptions—						
Royal Society	76	18	0			
Field Naturalists' Section ...	23	2	6			
				100	0	6
,, Grants from Government—						
On Subscriptions	54	6	9			
For Printing Reports and Scientific Investigations ...	150	0	0			
				204	6	9
,, Receipts for use of Room by other Societies				5	18	6
,, Sale of Publications				4	3	11
,, Savings Bank Interest				6	0	1
,, Interest transferred from Endowment Fund				130	15	8
				£842	16	11

	£	s.	d.	£	s.	d.
By Transactions—						
Printing	134	13	8			
Illustrating	90	8	6			
Publishing	2	17	11			
				228	0	1
,, Grant—						
Field Naturalists' Section				25	0	0
,, Library—						
Librarian, Cataloguing, Receiving and Issuing				19	7	4
,, Sundries—						
Cleaning and Lighting ...	13	5	10			
Printing, Postages, Stationery	18	2	4			
Advertising	2	8	6			
Insurance	2	10	8			
				36	7	4
,, Balance September 30, 1919—						
Savings Bank of S.A.	361	15	2			
Bank of Australasia	172	3	10			
Cash in Hand	0	3	2			
				534	2	2
				£842	16	11

Audited and found to be correct—

B. S. Roach,
Howard Whitbread, } *Hon. Auditors.*

W. B. Poole, *Hon. Treasurer.*

Adelaide, October 3, 1919.

ENDOWMENT FUND.

(Capital, £3,579 17s. 6d.)

	£	s.	d.	£	s.	d.
1918—October 1.						
To Balance	3,479	17	6			
Donation	100	0	0			
				3,579	17	6
,, Interest received on Government Stock	130	12	6			
,, Savings Bank Interest	0	3	2			
				130	15	8
				£3,710	13	2

	£	s.	d.	£	s.	d.
1919—September 30.						
By £2,000 S.A. Government 3¾% Inscribed Stock at cost ...	1,997	10	0			
,, £450 S.A. Government 3¾% Inscribed Stock at cost ...	432	0	0			
,, £800 S.A. Government 3¾% Inscribed Stock at cost ...	753	10	8			
,, £500 S.A. Government Consolidated 3% Stock at cost ...	292	8	9			
,, £100 S.A. Government 5% Inscribed Stock	100	0	0			
,, Savings Bank Account	4	8	1			
				3,579	17	6
,, Interest transferred to Revenue Account				130	15	8
				£3,710	13	2

Audited and found correct—

B. S. Roach, }
Howard Whitbread, } *Hon. Auditors*

Adelaide, October 3, 1919.

W. B. Poole, *Hon. Treasurer.*

DONATIONS TO THE LIBRARY

FOR THE YEAR ENDED SEPTEMBER 30, 1919.

TRANSACTIONS, JOURNALS, REPORTS, ETC.,
presented by the respective governments, societies, and editors.

AUSTRALIA.

AUSTRALASIAN INSTITUTE OF MINING ENGINEERS. Proc., n.s., no. 31-34. Melb. 1918-19.
AUSTRALIA. *Advisory Council of Science and Industry.* Bull. 8-13. Melb. 1918-19.
——— ——— Mem., no. 1. Melb. 1918.
——— ——— Report, 1918. Melb.
——— *Institute of Science and Industry.* Science and industry, v. 1, no. 1-4. Melb. 1919.
——— *Bureau of Census and Statistics.* Yearbook, 1918.
——— *Bureau of Meterology.* Monthly report, v. 4, no. 8-9.
——— ——— Orographical maps.
——— ——— Rainfall observations in S.A. and the N.T., 1917-18.
——— *Fisheries.* Zoological results of fishing experiments carried out by F.I.S. "Endeavour," v. 4, pt. 6; 5, pt. 1.
——— *Northern Territory.* Bull., no. 18. 1918.
——— ——— Report of administrator, 1918.

NEW SOUTH WALES.

AUSTRALIAN MUSEUM. Records, v. 12, no. 6-10.
——— Report of the trustees to June, 1918. Syd.
LINNEAN SOCIETY OF N.S.W. Proc., v. 43, pt. 3-4; 44, pt. 1.
MAIDEN, J. H. Critical revision of the genus Eucalyptus, pt. 36-38. Syd. 1918-19.
NEW SOUTH WALES. *Botanic Gardens.* Report, 1917.
——— *Board of Fisheries.* Report, 1917. Syd.
——— *Dept. of Agriculture.* Agricultural gazette of N.S.W., v. 29, pt. 10-12; 30, pt. 1-9. Syd. 1918-19.
——— *Dept. of Mines.* Annual report, 1918. Syd.
——— ——— Mineral resources, no. 25. Syd. 1919.
——— *Dept. of Public Health.* Report, 1917. Syd. 1919.
——— *Geological Survey.* Mem., ethnological ser., No. 3.
ROYAL SOCIETY OF N.S.W. Proc., v. 51. Syd. 1917.
SYDNEY UNIVERSITY. Calendar, 1919.

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——— ——— Jour., v. 10-11; 12, pt. 1-3. 1918-19.
——— *Geological Survey.* Publications 262-264. 1918.
QUEENSLAND MUSEUM. Mem., v. 6. Brisb. 1918.
ROYAL SOCIETY OF QUEENSLAND. Proc., v. 30. 1918.

SOUTH AUSTRALIA.

PUBLIC LIBRARY, MUSEUM, AND ART GALLERY OF S.A. Report, 1917-18. Adel. 1918.
——— Records of the S.A. Museum, v. 1, no. 2. 1919.
SOUTH AUSTRALIA. *Dept. of Mines.* Review of mining operations in S.A., no. 28-29. Adel. 1918.
——— Government Geologist's report, 1917.
——— *Woods and Forests Dept.* Report, 1917-18.
S.A. SCHOOL OF MINES AND INDUSTRIES. Report, 1918.

TASMANIA.

ROYAL SOCIETY OF TASMANIA. Proc., 1918. Hobart. 1919.
TASMANIA. *Geological Survey.* Bull. 29. Hobart. 1919.
TASMANIA, UNIVERSITY OF. Calendar, 1918-19.

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ROYAL SOCIETY OF VICTORIA. Proc., n.s., v. 31, pt. 1-2.
VICTORIA. *Dept. of Agriculture.* Jour., v. 16, pt. 10-12; 17, pt. 1-9. Melb. 1918-19.
——— *Geological Survey.* Bull. 39, 41. Melb. 1918.
VICTORIAN NATURALIST, v. 35, no. 6-12; 36, no. 1-5.

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CAMBRIDGE PHILOSOPHICAL SOCIETY. Proc., v., 19, pt. 5.
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CAMBRIDGE UNIVERSITY. *Solar Physics Observatory.* Report, 1916-19.
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*FORBES, HY. O. Handbook to the Primates, v. 1-2. Lond.
GEOLOGICAL SOCIETY OF LONDON. Quarterly journal, v. 73, pt. 2-4; 74, pt. 1-2. 1918-19.

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Imperial Institute. Bull., v. 16. Lond. 1918-19.
*Kirby, W. F. Handbook to the lepidoptera, v. 1-5.
Linnean Society of London. Trans.: botany, v. 9, pt. 1.
——— Trans.: zoology, v. 17, pt. 3. 1917.
*Lydekker, R. Handbook to the British mammalia.
*——— Handbook to the carnivora, pt. 1. Lond. 1896.
*——— The marsupialia and monotremata. 1896.
Manchester Literary and Philosophical Society. Mem. and proc., v. 62. 1918-19.
National Physical Laboratory. Collected researches, v. 13.
——— Report, 1916-18. Lond.
*Ogilvie-Grant, W. R. Handbook to the game-birds, v. 1-2.
Oxford University Press. Periodical, no. 97-100. 1918.
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Royal Colonial Institute. United Empire, v. 9, no. 7-9, 12; 10, no. 1-7. Lond. 1918-19.
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Royal Microscopical Society. Jour., 1918, pt. 2-4; 1919, pt. 1. Lond.
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Geological Society of Glasgow. Trans., v. 15, pt. 3; 16, pt. 1-2.
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——— Trans., v. 52, pt. 1-2. 1918-19.

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Academia Nacional de Ciencias en Cordoba. Boletin, t. 23, entr. 1-2. Buenos Aires. 1918.

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Société Royale de Botanique de Belgique. Bull., t. 53, no. 1. Bruxelles. 1914.
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BRAZIL.

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INSTITUTO OSWALDO CRUZ. Mem., t. 10, fasc. 1. 1918.
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CANADA.

CANADA. *Geological Survey.* Mem. 82, 95, 96, 103.
——— ——— Museum bull., no. 27-28. Ottawa. 1918.
——— ——— Publications, 1718-21, 1727, 1734, 1738.
——— *Mines.* Bull. 20, 22-24, 26, 28.
——— ——— Publications, 452, 468, 474, 493, 504.
CANADIAN INSTITUTE. Trans., v. 12, pt. 1. Ottawa. 1919.
NOVA SCOTIAN INSTITUTE OF SCIENCE. Proc., v. 14, pt. 3.
OTTAWA NATURALIST, v. 32, no. 1, 3-6. 1918.
ROYAL SOCIETY OF CANADA. Proc., v. 12. 1918-19.

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K. DANSKE VIDENSKABERNES SELSKAB. Biologiska med., I, 1-12, 14. Cpng. 1917-19.
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——— Skrifter: hist. og fil., ser. 7, t. 3, no. 3. 1918.
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BONAPARTE, PRINCE. Notes ptéridologiques, 5, 7. 1918.
SOCIÉTÉ ENTOMOLOGIQUE DE FRANCE. Annales, v. 86, pt. 4; 87.
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——— ——— Chemical ser., v. 5, no. 2-4. 1918.
——— ——— Report, 1917-18. Calc. 1919.
——— *Geological Survey.* Bibliography of Indian geology and physical geography, pt. 1-2. Calc. 1917-18.
——— ——— Records, v. 49; 50, pt. 1. 1918.
——— *Pusa Agricultural Institute.* Report, 1917-18.
——— *Zoological Survey.* Report, 1916-17, Calc.
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——— Records, v. 8, pt. 9-12; 12, pt. 4-8; 13-15; 16, pt. 1-4.
——— Report, 1915-16. Calc.
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MALPIGHIA, anno. 28, fasc. 7-8. Catania. 1918.
SOCIETÀ ENTOMOLOGICA ITALIANA. Bull., anno. 49.
SOCIETÀ ITALIANA DI SCIENZE NATURALI. Atti, v. 56, fasc. 1-2; 57, 58, fasc. 1. Pavia. 1917-19.
SOCIETÀ TOSCANA DI SCIENZE NATURALI. Processi verbali, v. 26, no. 4; 27, no. 1-2. Pisa. 1917-18.
ZOOLOGIA GENERALE E AGRARIA. Boletino del laboratorio, v. 12. Portici. 1917-18.

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IMPERIAL ACADEMY. Proc., v. 1, No. 5. Tokyo. 1918.
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KYOTO IMPERIAL UNIVERSITY. *College of Engineering.* Mem., v. 2, no. 1-3. 1918.
——— *College of Science.* Mem., v. 3, no. 5-10. 1918-19.
TOHÔKU IMPERIAL UNIVERSITY. Science reports: 1st ser., v. 7, no. 2-3; 8, no. 1; 2nd ser., v. 4, no. 3; 5, no. 1.
TOHÔKU MATHEMATICAL JOURNAL, v. 14, no. 3-4; 15; 16, no. 1-2. Sendai. 1917-19.
TOKYO IMPERIAL UNIVERSITY. Calendar, 1917-18.
——— *College of Science.* Jour., v. 39, art. 9; 40, art. 7; 42, art. 1. 1918-19.

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NEDERLANDSCH OOST INDIË. *Hoofd-Bureau Mijnwezen.* Jaarboek, 1916, pt. 1, and atlas. Batavia. 1918.

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——— Boletin, no. 35-36. Mexico. 1918.
SOCIEDAD CIENTIFICA "ANTONIO ALZATE." Mem. 37, no. 1-2; 38, no. 1-8. Mexico. 1918-19.

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AUCKLAND INSTITUTE AND MUSEUM. Report, 1918-19.
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——— *Dept. of Internal Affairs.* Report of Dominion laboratory, no. 51. Well. 1918.
——— *Dept. of Mines.* Palaeontological bull., no. 7. 1918.

NORWAY.

BERGENS MUSEUM. Aarbog, 1916-17, pt. 2; 1917-18, pt, 1, 3.
——— Aarsberetning, 1917-18.
K. NORSKE VIDENSKABERS SELSKABS. Skrifter, 1915.
——— Johann Ernst Gunnerus. Trondhjem. 1918.
STAVANGER MUSEUM. Aarshefte, 1917.

PERU.

CUERPO DE INGENIEROS DE MINAS. Bull. 87, 89-95. Lima.

PHILIPPINE ISLANDS.

PHILIPPINE ISLANDS. *Bureau of Gov't Laboratories.* Publications, no. 29, 35. Manila. 1905.
——— *Bureau of Science.* Ethnological survey publications, v. 5, pt. 6. Manila. 1917.
——— ——— Journal of science, sect. A, v. 1-13; B, v. 2-13; C, v. 2-13; D, v. 5-13. Manila. 1906-18.
——— ——— Mineral resources of the P.I., 1913-16.

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JUNTA DE CIENCIES NATURALS DE BARCELONA. Ser. zool, 4, 8.
——— Anvari 2, pt. 1-2. Barcelona. 1917.

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K. VITTERHETS HISTORIE OCH ANTIKVITETS AKADEMIEN. Fornvännen, 1916. Stockholm.

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Geological Society of South Africa. Trans., 1918.

Royal Society of South Africa. Trans., v. 7, pt. 1-3.

South African Association for the Advancement of Science. Jour. of Science, v. 15, no. 1-7.

South African Museum. Annals, v. 12, pt. 6. 1918.

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Academy of Natural Sciences of Philadelphia. Jour., ser. 2, v. 16, pt. 4. Philad. 1918.

——— Proc., v. 69, pt. 2-3; 70, pt. 1-2. 1917-18.

American Chemical Society. Journ., v. 40, no. 11-12; 41, n. 1-7. Easton, Pa. 1918-19.

American Geographical Society. Geographical review, v. 6-7. N.Y. 1918-19.

American Institute of Mining Engineers. Trans., v. 57-59, N.Y. 1918-19.

American Microscopical Society. Trans., v. 36, no. 3-4; 37, no. 1-2, 4; 38, no. 1. Menasha, Wis. 1917-19.

American Museum of Natural History. Anthropological papers, v. 10, pt. 5-6; 16, pt. 3; 18, pt. 4; 20, pt. 1; 22, pt. 2; 23, pt. 1-2; 24, pt. 1.

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——— Guide leaflets, No. 46, 48. N.Y. 1917-18.

——— Handbook ser., no. 3, 7. N.Y. 1917-18.

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Bernice Pauahi Bishop Museum. Mem., v. 5, pt. 1-2.

——— Polynesian ethnology, v. 6, no. 5. Honolulu. 1918.

Brooklyn Institute of Arts and Sciences. Museum quarterly, v. 4, no. 3; 5, no. 1, 3. 1917-18.

California Academy of Sciences. Proc., ser. 4, v. 2, pt. 1, no. 11 and pt. 2, no. 12; 6, no. 8-9; 7, no. 1-13; 8, no. 1-4. 1917-18.
California. *Mining Bureau.* Bull. 76, 78, 83. 1918.
——— ——— Preliminary report, no. 4-5. Sacramento.
California University. *Agricultural Experiment Station.* Bull. 292, 301. Berkeley. 1918.
——— *Dept. of Geology.* Bull., v. 10, no. 11-22, 25; 11, no. 2-4.
——— Publications in American archaeology and ethnology, v. 12, no. 8-11; 13, no. 1. 1917.
——— Publications in botany, v. 6, no. 13-14. Berkeley.
——— Publications in zoology, v. 14, no. 2; 16, no. 20-24; 17, no. 8, 10-11; 18, no. 17; 19, no. 1-3; 20, no. 1-4; 21, no. 1-2. Berkeley. 1918-19.
Cincinnati Society of Natural History. Jour., v. 22, no. 2.
Cornell University. *Agricultural Experiment Station.* Bull. 391.
——— ——— Mem. 11. Ithaca, N.Y. 1917.
Florida. *Geological Survey.* Report 12. 1919.
Franklin Institute. Jour., v. 186; no. 2-6; 187; 188, no. 1. Philad. 1918-19.
Harvard College. *Museum of Comparative Zoology.* Bull., v. 62, no. 5-11, 14; 63, no. 2-3. 1918-19.
——— ——— Report, 1917-18. Camb., Mass.
Hawaiian Entomological Society. Proc., v. 4, no. 1.
Illinois. *State Laboratory of Natural History.* Bull., v. 11, art. 8-10; 13, art. 1-4, 7-8. Urbana. 1918.
Indiana Academy of Science. Proc., 1916-17.
Leland Stanford Jr. University. Bull. 95. 1917.
——— Trustees' ser., No. 31. 1916.
——— University ser., no. 24-29. 1916-17.
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——— *Agricultural Experiment Station.* Bull. 165-168.
National Academy of Sciences. Proc., v. 4, no. 7-12; 5, n. 1-6. Wash. 1918-19.
New York Academy of Sciences. Annals, v. 27, pp. 215-243.
New York Public Library. Bull., v. 22, no. 6-12; 23, no. 1-7.
New York State Museum. Report 69. 1915. Albany.
N. Carolina. *Geological and Economic Survey.* Biennial report, 1891-1914.

N. CAROLINA. *Geological and Economic Survey.* Bull. 2-3, 5, 7-8, 10-13, 15, 17-25.
——— ——— Economic papers, 1-20, 23-25, 28-42.
——— ——— [Publication] v. 1, 3. 1905-12.
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——— Wilson bull., v. 30, no. 3-4; 31, no. 1-2. 1918.
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——— Ohio journal of science, v. 18, no. 7-8; 19, no. 1-7.
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SMITHSONIAN INSTITUTION. Report, 1916. Wash. 1917.
——— *Bureau of American Ethnology.* Bull. 61, 63.
UNITED STATES. *Dept. of Agriculture.* 18 bull. of dept.
——— ——— Farmers' bull., 915, 921, 932. Wash.
——— ——— journal of agricultural research, v. 10, no. 13; 12, no. 12; 14, no. 5-12; 15-16; 17, no. 1-3.
——— ——— N. American fauna, no. 41-43. 1917-18.
——— *Library of Congress.* Report, 1917. Wash.
——— *National Museum.* Annual report, 1917-18.
——— ——— Bull. 97; 99; 100, v. 2, pt. 1-2, 4-5; 102, pt. 1, 4-7; 103, pp. 1-188, 525-612; 104; 105.
——— ——— Contributions from the National Herbarium, v. 20, pt. 4-5. 1918.
——— ——— Proc., v. 51-53. Wash. 1917-18.
VIRGINIA. *Geological Survey.* Bull. 1A-10, 12-15.
WAGNER FREE INSTITUTE OF SCIENCE. Trans., v. 8.
——— Annual announcement, 1917-19. Philad.
WASHINGTON UNIVERSITY, ST. LOUIS. Studies, v. 4, pt. 1, no. 2; 5, no. 1-2; 6, no. 1. 1917-18.

LIST OF FELLOWS, MEMBERS, Etc.,

AS EXISTING ON

SEPTEMBER 30, 1919.

Those marked with an asterisk have contributed papers published in the Society's Transactions.

Any change in address should be notified to the Secretary.

Note.—The publications of the Society will not be sent to those whose subscriptions are in arrears.

Date of Election.

Honorary Fellows.

1910. *Bragg, W. H., C.B.E., M.A., F.R.S., Professor of Physics, University College, London (Fellow 1886).
1893. *Cossmann, M., 110, Faubourg Poissonnière, Paris.
1897. *David, T. W. Edgeworth, C.M.G., B.A., D.Sc., F.R.S., F.G.S., Professor of Geology, University of Sydney.
1890. *Etheridge, Robert, jun., Director and Curator of the Australian Museum of New South Wales, Sydney.
1905. Gill, Thomas, C.M.G., I.S.O., Under-Treasurer, Adelaide.
1905. *Hedley, Chas., Assistant Curator, Australian Museum, Sydney.
1892. *Maiden, J. H., I.S.O., F.R.S., F.L.S., Director Botanic Gardens, Sydney, New South Wales.
1898. *Meyrick, E. T., B.A., F.R.S., F.Z.S., Tohrnhanger, Marlborough, Wilts, England.
1894. *Wilson, J. T., M.D., Ch.M., Professor of Anatomy, University of Sydney, New South Wales.
1912. *Tepper, J. G. O., F.L.S., Elizabeth Street, Norwood (Corresponding Member 1878, Fellow 1886).

Corresponding Members.

1913. *Carter, H. J., B.A., Wahroonga, New South Wales.
1909. *Johncock, C. F., Clare.
1893. *Stretton, W. G., Darwin, Northern Territory.
1905. Thomson, G. M., F.L.S., Dunedin, New Zealand.
1908. *Woolnough, Walter George, D.Sc., F.G.S., Professor in Geology, University of Perth (Fellow 1902).

Fellows.

1918. Andrew, H. W., North Street, Collinswood.
1895. *Ashby, Edwin, F.L.S., M.B.O.U., Blackwood.
1917. Bailey, J. F., Director Botanic Garden, Adelaide.
1902. *Baker, W. H., F.L.S., King's Park.
1907. *Black, J. McConnell, 1, Brougham Place, North Adelaide.
1912. *Broughton, A. C., Young Street, Parkside.
1911. Brown, Edgar J., M.B., D.Ph., 3, North Terrace.
1883. *Brown, H. Y. L., 286, Ward Street, North Adelaide.
1893. Brummitt, Robert, M.R.C.S., Northcote Ter., Medindie.
1916. *Bull, Lionel B., D.V.Sc., Laboratory, Adelaide Hospital.

1907. *Chapman, R. W., M.A., B.C.E., F.R.A.S., Professor of Mathematics and Mechanics, University of Adelaide.
1904. Christie, W., 49, Rundle Street, Adelaide.
1895. *Cleland, John B., M.D., Government Bureau of Microbiology, Sydney, New South Wales.
1907. *Cooke, W. T., D.Sc., Lecturer, University of Adelaide.
1912. Corbin, H. H., B.Sc., University of Adelaide.
1914. Cornish, K. M., on Active Service.
1916. Darling, H. G., Franklin Street, Adelaide.
1887. *Dixon, Samuel, Bath Street, New Glenelg.
1915. Dodd, Alan P., Kuranda, Queensland.
1911. Dutton, H. H., B.A. (Oxon.), Anlaby,
1902. Edquist, A. G., 20, King Street, Mile End.
1918. *Elston, A. H., F.E.S., Childers Street, North Adelaide.
1917. Fenner, A. E., D.Sc., F.G.S., Education Department, Adelaide.
1914. Ferguson, E. W., M.B., Ch.M., Gordon Road, Roseville, Sydney.
1919. Glastonbury, O. A., Adelaide Cement Co., Brookman Buildings.
1904. Gordon, David, c/o D. & W. Murray, Gawler Place, Adelaide.
1880. *Goyder, George, A.M., F.C.S., Gawler Place, Adelaide.
1910. *Grant, Kerr, M.Sc., Professor of Physics, University of Adelaide.
1904. Griffith, H., Brighton.
1919. Grigson, E. C., 99, Grant Avenue, Rose Park.
1916. Hackett, W. C., Rundle Street, Adelaide.
1916. Hancock, H. Lipson, A.M.I.C.E., M.I.M.M., M.Am.I.M.E., Kennedya, Wallaroo Mines.
1896. Hawker, E. W., F.C.S., East Bungaree, Clare.
1883. *Howchin, Walter, F.G.S., Professor of Geology and Palaeontology, University of Adelaide.
1918. Ising, Ernest H., Loco. Department, Islington.
1912. Jack, R. L., B.E., Assistant Government Geologist, Adelaide.
1893. James, Thomas, M.R.C.S., Tranmere, Magill.
1918. Jenison, Rev. J. C., Mount Barker.
1910. *Johnson, E. A., M.D., M.R.C.S., 295, Pirie Street, Adelaide.
1918. Kimber, W. J., Gaza.
1915. *Laurie, D. F., Agricultural Department, Victoria Square.
1897. *Lea, A. M., F.E.S., South Australian Museum, Adelaide.
1884. Lendon, A. A., M.D. (Lond.), M.R.C.S., Lecturer in Obstetrics, University of Adelaide, and Hon. Physician, Children's Hospital, North Adelaide.
1888. *Lower, Oswald B., F.Z.S., F.E.S., 18, Bartley Crescent, Wayville.
1914. Mathews, G. M., F.R.S.E., F.L.S., F.Z.S., Foulis Court, Fair Oak, Hants, England.
1905. *Mawson, Sir Douglas, D.Sc., B.E., Lecturer in Mineralogy and Petrology, University of Adelaide.
1874. Mayo, Geo. G., C.E., 90, Hill Street, North Adelaide.
1919. Mayo, Helen M., M.B., B.Sc., 47, Melbourne Street, North Adelaide.
1907. Melrose, Robert Thomson, Mount Pleasant.
1897. *Morgan, A. M., M.B., Ch.B., 46, North Terrace, Adelaide,

1913. *Osborn, T. G. B., M.Sc., Professor of Botany, University of Adelaide.
1886. Poole, W. B., 6, Rose Street, Prospect.
1911. Poole, His Honor Justice T. S., K.C., B.A., LL.B., *Register* Chambers, Grenfell Street.
1908. Pope, William, Eagle Chambers, Pirie Street.
1907. *Pulleine, Major R. H., M.B., 3, North Terrace, Adelaide.
1916. Ray, William, M.B., B.Sc., Victoria Square, Adelaide.
1885. *Rennie, Edward H., M.A., D.Sc. (Lond.), F.C.S., Professor of Chemistry, University of Adelaide.
1913. *Riddle, A. R., 127, Park Terrace, Wayville West.
1911. Roach, B. S., Education Department, Flinders Street, Adelaide.
1905. *Rogers, Lieut.-Col. R. S., M.A., M.D., Flinders Street, Adelaide.
1869. *Rutt, Walter, C.E., College Park, Adelaide.
1891. Selway, W. H., Treasury, Adelaide.
1906. Snow, Francis H., National Mutual Buildings, King William Street.
1910. *Stanley, E. R., Government Geologist, Port Moresby, Papua.
1907. Sweetapple, H. A., M.D., Park Terrace, Parkside.
1897. *Torr, W. G., LL.D., M.A., B.C.L., Brighton, South Australia.
1894. *Turner, A. Jefferis, M.D., F.E.S., Wickham Terrace, Brisbane, Queensland.
1878. *Verco, Sir Joseph C., M.D. (Lond.), F.R.C.S.
1914. *Waite, Edgar R., F.L.S., Director South Australian Museum.
1912. Ward, Leonard Keith, B.A., B.E., Government Geologist, Adelaide.
1878. Ware, W. L., King William Street.
1907. Webb, Noel A., Barrister, Westall Street, Hyde Park.
1919. Whalley, Rev. D. T., Prince's Street, Alberton.
1904. Whitbread, Howard, c/o A. M. Bickford & Sons, Currie Street, Adelaide.
1912. *White, Captain S. A., C.M.B.O.U., "Wetunga," Fulham, South Australia.
1912. *Zietz, F. R., South Australian Museum.

Associate.

1904. Robinson, Mrs. H. R., "Las Conchas," Largs Bay, South Australia.

APPENDICES.

FIELD NATURALISTS' SECTION

OF THE

Royal Society of South Australia (Incorporated)

THIRTY-SIXTH ANNUAL REPORT OF THE COMMITTEE.

For the Year Ended September 30, 1919.

The following Officers were elected at the last Annual Meeting:—*Chairman*, Mr. W. J. Kimber: *Vice-Chairmen*, Dr. C. Fenner, F.G.S., and Mr. J. F. Bailey; *Hon Treasurer*, Mr. B. B. Beck; *Hon. Librarian*, Miss I. Roberts; *Hon. Secretary*, Mr. E. H. Ising; *Hon. Assistant Secretary*, Miss E. Ireland; *Press Correspondent*, Mr. D. J. McNamara; *Committee*, Prof. T. G. B. Osborn, M.Sc., Mr. E. H. Lock, F.R.H.S., Mr. P. Runge, Mr. W. H. Selway, Mr. A. H. Elston, Mr. W Ham, Mr. E. S. Hughes, Mrs. F. J. Mellor, and the Chairman and Secretary of the Fauna and Flora Protection Committee *(ex officio)*; *Hon. Auditors*, Messrs. Walter D. Reed, F.C.P.A., and W. A. Drummond.

The Fauna and Flora Protection Committee was elected as follows:—Capt. S. A. White, Mr. E. Ashby, Dr. W. Ramsay Smith, Messrs. W. H. Selway, A. M. Lea, S. Angel, J. M. Black, and A. H. Elston, Dr. Fenner, Messrs. J. F. Bailey, P. Runge, H. W. Andrew, and A. R. Riddle, and Chairman and Secretary of the Section *(ex officio)*.

The membership of the Section is now 125.

The following Evening Meetings were held:—

September 17, 1918—Annual Meeting.

October 1, 1918—Address: "The Attractions of Port Willunga to the Nature Study Student."

October 15, 1918—Exhibits by Members.

November 19, 1918—Description by Members of Excursion to Moolooloo, in the Flinders Range.

April 15, 1919—Lecture: "Palms and Cycads." Mr. J. F, Bailey.

May 20, 1919—Lecture: "Climatic Control of Civilization." Dr. C. Fenner.

June 17, 1919—Lecture: "Travel Chat." Sir William Sowden.

July 15, 1919—Lecture: "The earth as an abode of Life." Mr. G. F. Dodwell, B.A.

August 22, 1919—Lecture: "American Birds at Home." Mr. E. Ashby.

September 22, 1919—Lecture: "The Old Dutch Houses at the Cape." Capt. S. A. White.

The following Excursions were held:—

September 21, 1918—Tea Tree Gully: Ornithology. Capt. S. A. White.

September 28, 1918—Blackwood to Eden: Physiography. Mr. A. G. Edquist.

October 5, 1918—Aldgate to Bridgewater: Native Flora. Mr. W. H. Selway.

October 9, 1918—Cherry Gardens: Botany. Mr. W. Ham.

October 19, 1918—Paradise: Introduced Plants. Mr. H. W. Andrew.

October 26, 1918—Gilles Plains: Fruit Culture. Mr. W. J. Kimber.

November 30, 1918—Marino: Shells and Marine Life. Mr. W. J. Kimber.

January 18, 1919—Port River: Dredging Excursion. Mr. W. J. Kimber.

February 8, 1919—Blackwood: Experimental Orchard. Mr. G. Quinn.

March 15, 1919—Port River: Dredging Excursion. Mr. E. R. Waite.

Easter, April 18-21, 1919—New Era: The Murray River. Mr. E. H. Lock.

April 26, 1919—Bridgewater: Native Flora. Mr. E. H. Lock.

May 12, 1919—Sturt River: Geology. Professor W. Howchin, F.G.S.

May 24, 1919—Morialta Gorge: Physiography, etc. Dr. C. Fenner, F.G.S.

June 3, 1919—Port Noarlunga: Fossils and Shell Life. Dr. C. Fenner and Mr. W. J. Kimber.

June 13, 1919—Mount Pleasant: Geology, etc. Mr. W. Ham.

July 12, 1919—National Museum: Mr. E. R. Waite, F.L.S., Director.

July 26, 1919—Botanic Gardens: Trees and Shrubs. Mr. J. F. Bailey.

August 9, 1919—Slape Gully: Plant Life. Mr. W. H. Selway.

August 23, 1919—Henley Beach South: Dune Flora. Mr. G. H. Ising.

September 6, 1919—Blackwood: Native Flora. Mr. A. G. Edquist.

Detailed accounts of the various Lectures and Excursions are published in *The South Australian Naturalist*.

THIRTIETH ANNUAL REPORT OF THE NATIVE FAUNA AND FLORA PROTECTION COMMITTEE.

Four committee meetings were held during the year, and the attendance, on the whole, was good.

Many important matters have received the attention of committee during the year. One event took place which is one of the most important occurrences since the committee was formed, *viz.*, the constituting of Flinders Chase.

Flinders Chase (Kangaroo Island Reserve).

Early in the year the Chairman, accompanied by Mr. G. R. Laffer, M.P., a representative for the district (the Hon. A. H. Peake was prevented from going at the last moment), visited Kangaroo Island. The whole question was personally put forward at a meeting of the Kingscote District Council. After a protracted discussion it was agreed that local opposition to the proposal should cease, and that the Council was willing to have the boundaries of the reserve fixed from Cape Forbin, on the North Coast, running south to the Rocky River Freehold, thence following the freehold south, and then west to the coast. On returning to the city this action was followed up by the chairman having repeated interviews with the Hons. the Premier and the Attorney-General to ensure having the reserve properly constituted under Act of Parliament. Subsequently a promise was given by members of the Ministry that the Flinders Chase Reservation Bill would be introduced early in the middle session. This promise has been carried out and the Bill has now passed both Houses, practically without alteration. Thus after twelve years' hard struggle the Chase has been constituted. The area—about 200 square miles —is not large enough, but the Act provides for extension.

The Game Bill.

The Game Bill, drafted with a view to securing better protection of wild animals and birds, which lapsed in the first session of Parliament, was restored early in the second session, as promised, and after being much mutilated has become law; although several strong measures were lost, still it is a vast improvement on the old Act, and we must hope for amendments in the future.

Seals.

As a result of persistent representations made to the Honorable the Attorney-General, the chairman reported that both Gulfs had been closed against the slaughter of these animals. All waters and islands within a line drawn from Cape Borda to Cape Catastrophe, and from Cape Willoughby to Victor Harbour, including The Pages, now forms a sanctuary for seals.

Infringements of Animal Protection Laws.

The wrongful capture of seagulls near Glenelg and slaughter of kangaroos were discussed, and action deemed appropriate by the committee was taken. The Coorong Islands were visited by the Chairman, in company with Mr. G. R. Laffer, M.P., Chairman of Committees, and the Chief Inspector of Fisheries, and a number of notice boards, *re* absolute protection of birds, placed thereon.

Destruction of Native Flora.

The Local Government Department was communicated with respecting the indiscriminate destruction of native flora on public highways in certain districts.

Conclusion.

Personal efforts put forth by the Chairman towards finalizing the reservation of Flinders Chase and the gazetting of both gulfs as sanctuaries for seals were endorsed by the committee, and congratulations unanimously extended to him.

A letter of thanks was sent to the Press expressing appreciation for prominence given to Flora and Fauna Protection questions.

S. A. White, *Chairman.*

H. W. Andrew, *Hon Secretary.*

FIELD NATURALISTS' SECTION OF THE ROYAL SOCIETY.

Statement of Receipts and Expenditure for Year ended September, 1919.

General Account.

RECEIPTS.	£	s.	d.	EXPENDITURE.	£	s.	d.
By Balance brought forward	5	1	3	To Members' Subscriptions paid to Royal Society	23	2	6
,, Grant from Royal Society	25	0	0	,, Postages	8	4	11
,, Members' Subscriptions	23	2	6	,, Stationery	0	14	10
,, Bank Interest	0	10	11	,, Hire of Hall and Lantern	5	10	4
				,, Printing	9	14	0
				,, Advertising	0	18	0
				,, Binding Library Books	0	6	6
				,, Balance carried forward	5	3	7
	£53	14	8		£53	14	8
By Balance £5 3 7							

Excursion Account.

	£	s.	d.		£	s.	d.
By Balance brought forward	7	11	3	To Hire of Motors	30	0	0
,, Excursion Fares	39	1	0	,, Hire of Steam Tug	5	5	0
				,, Refreshments	0	6	6
				,, Gratuities to Sailors	0	10	0
				,, Cartage of Dredge	0	13	4
				,, Credit Balance	9	17	5
	£46	12	3		£46	12	3
By Balance £9 17 5							

Audited and found correct,

WALTER D. REED, F.C.P.A., } *Auditors.*
A. M. DRUMMOND, }

September 15, 1919.

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R. T. Baker.

Fig. 1.

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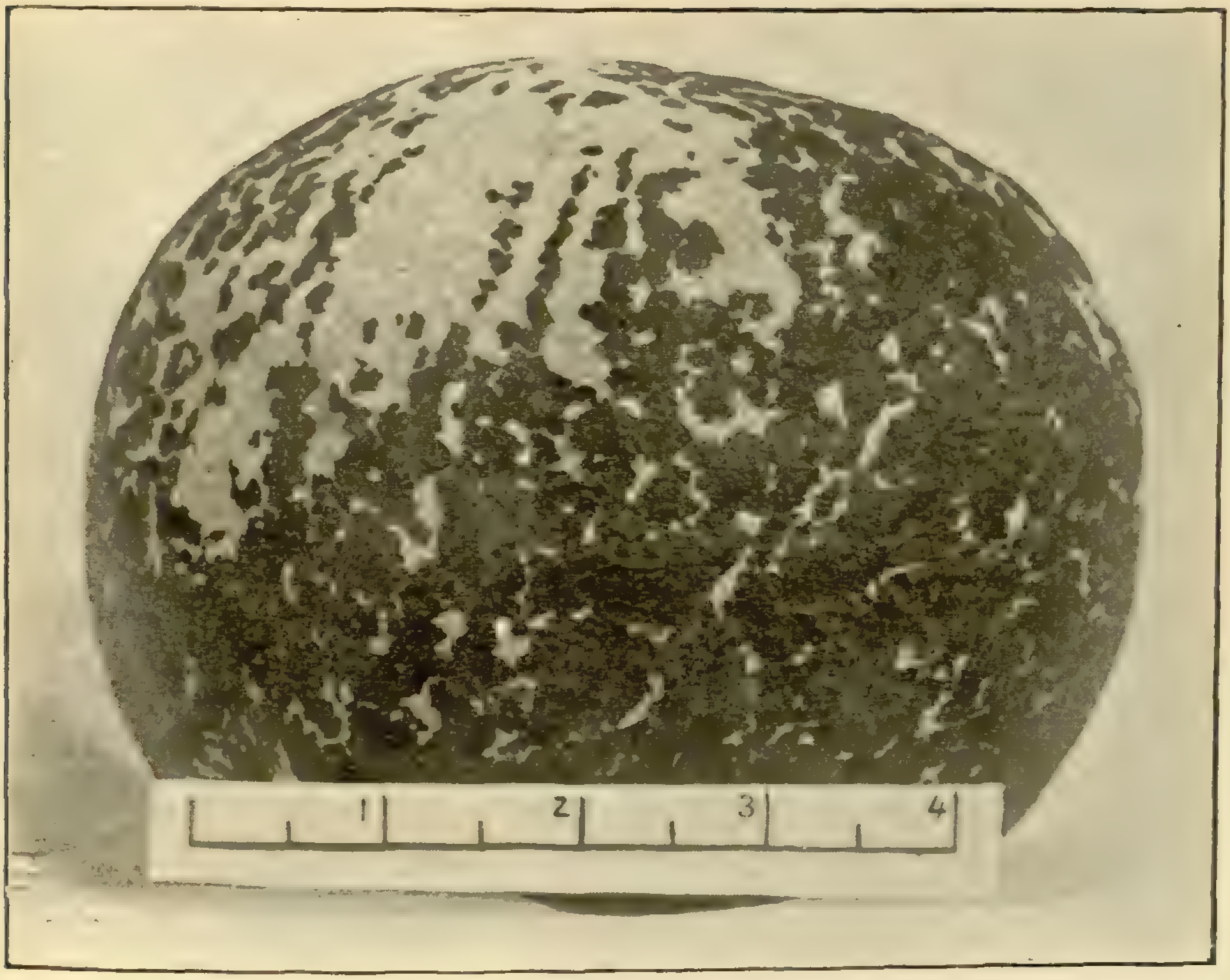
Fig. 2.



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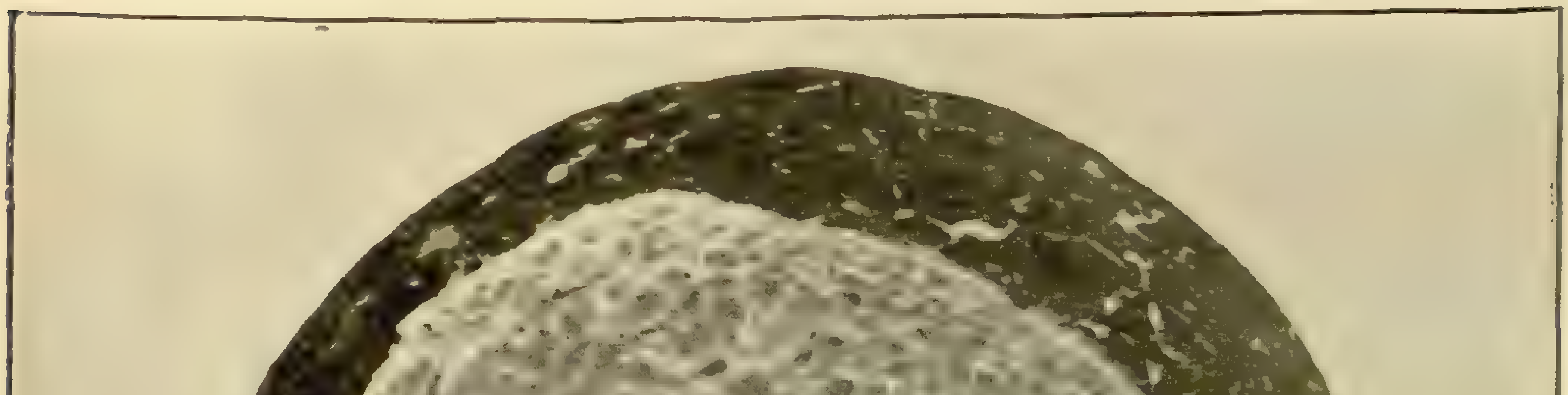

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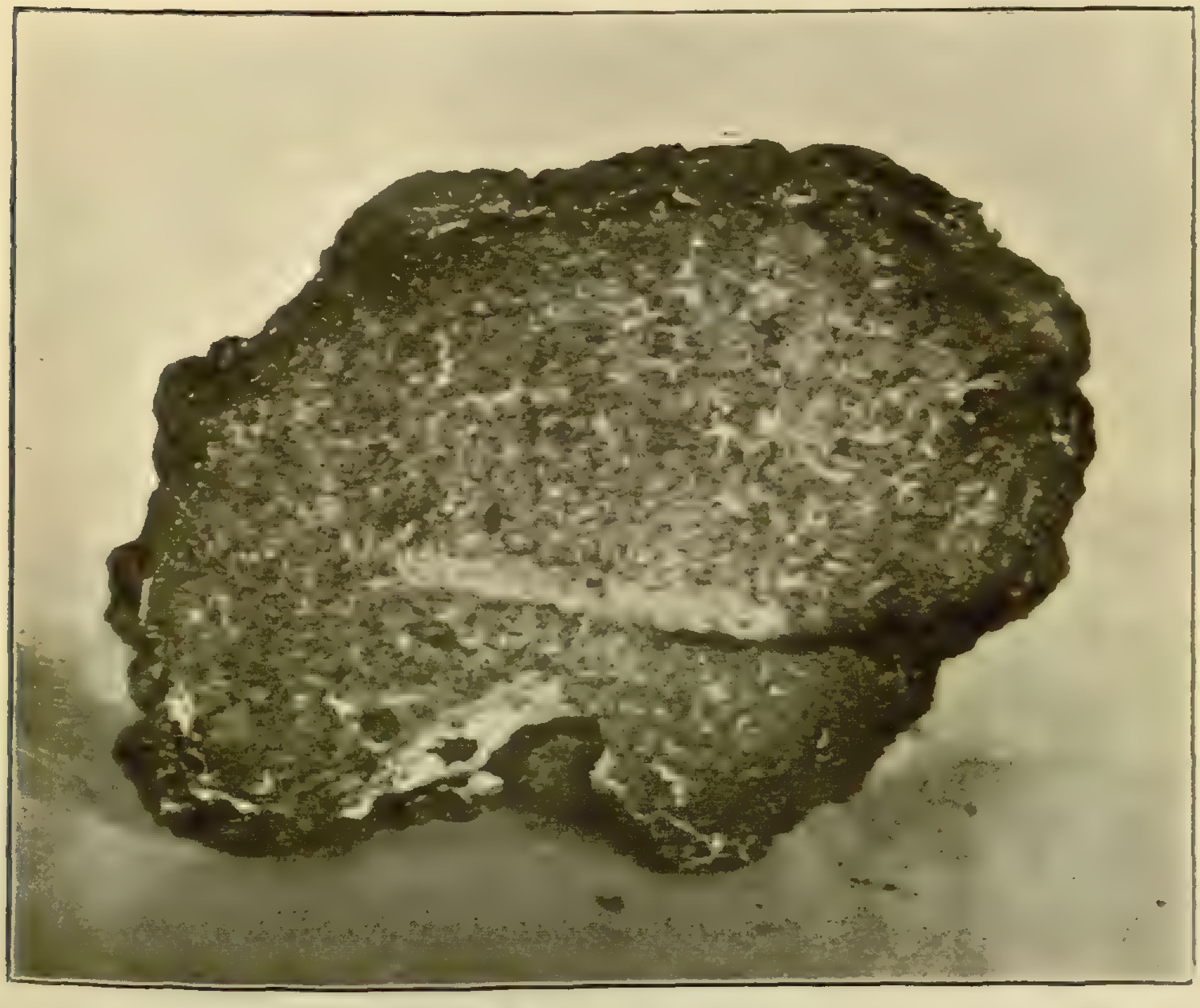

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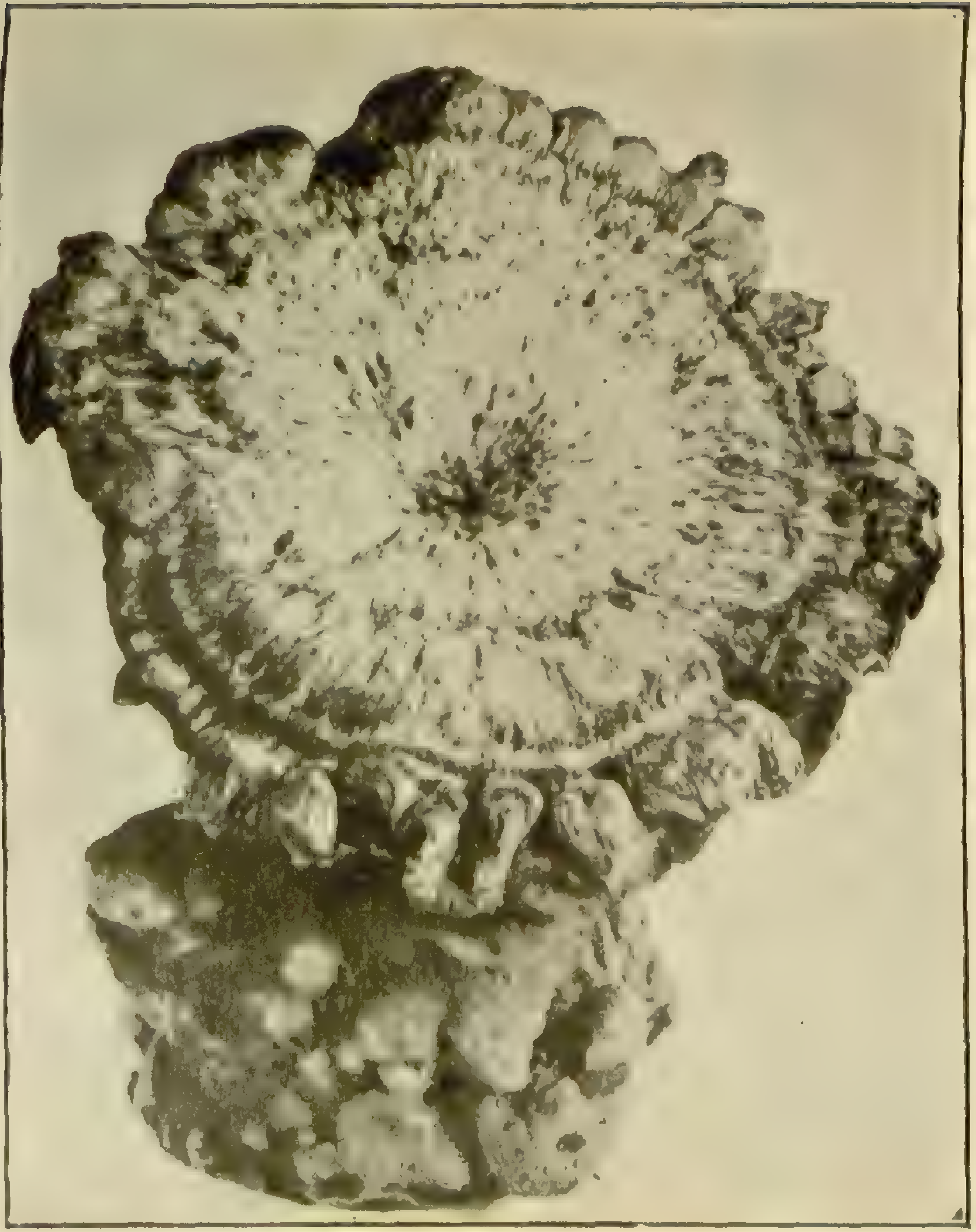

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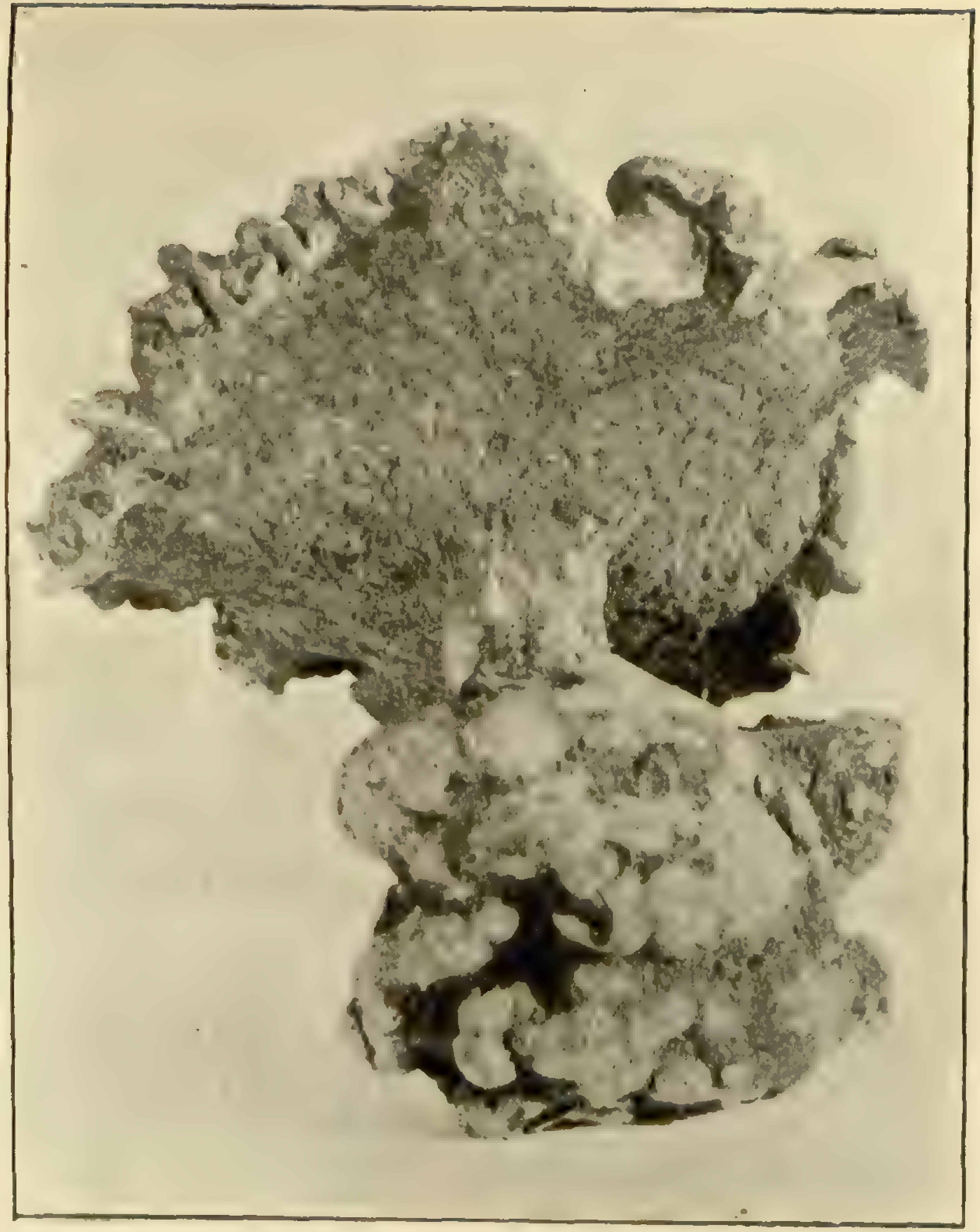

Fig. 2.

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Fig. 2.

Fig. 1.

Fig. 3.

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Kochia Cannonii *nov. sp.*

Pimelea Williamsonii *n. sp.*

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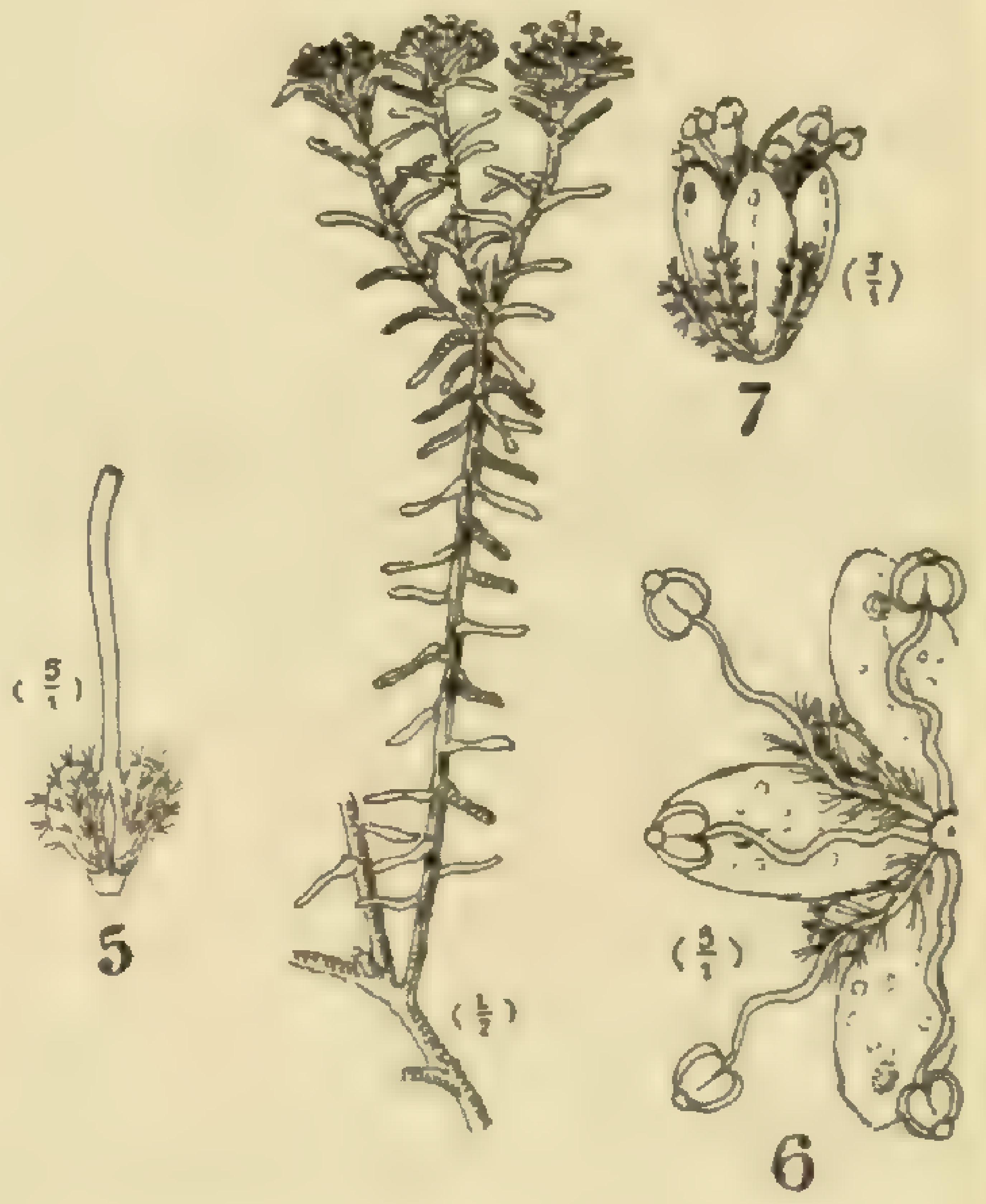
Goodenia vernicosa *n. sp.*



Microcybe pauciflora *Turcz*

M. multiflora *Turcz.*

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Erechthites prenanthoides *DC.*

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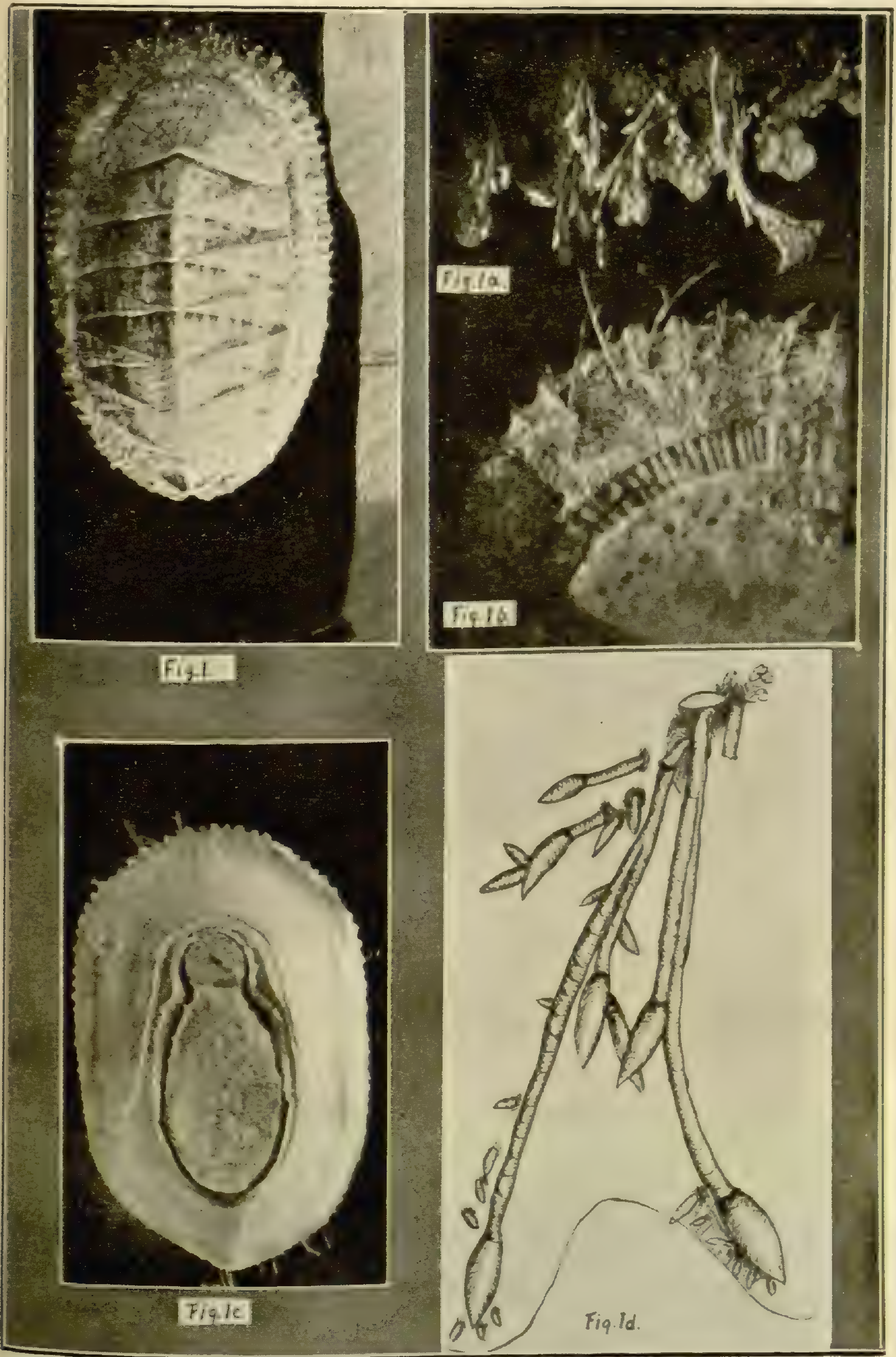

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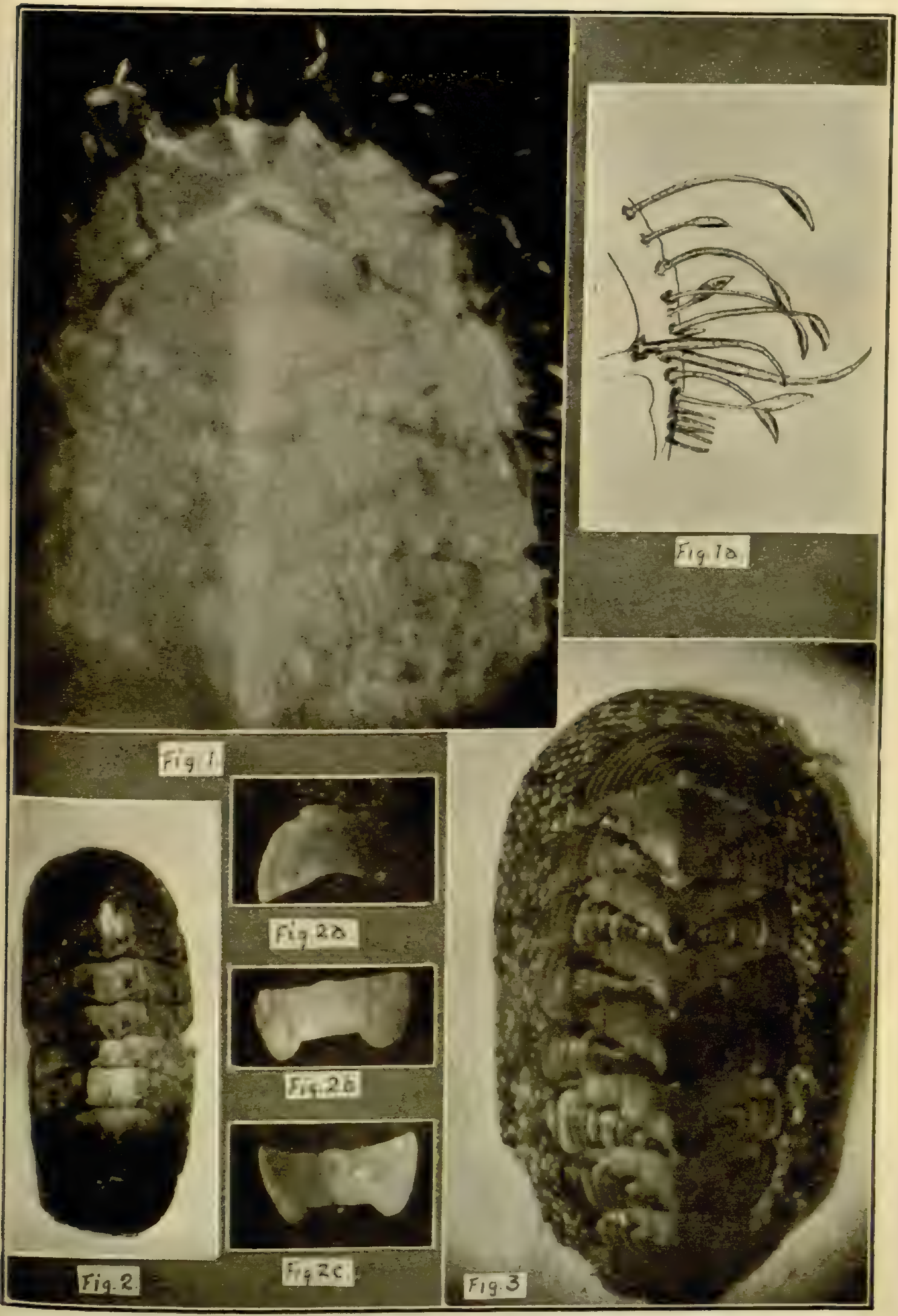

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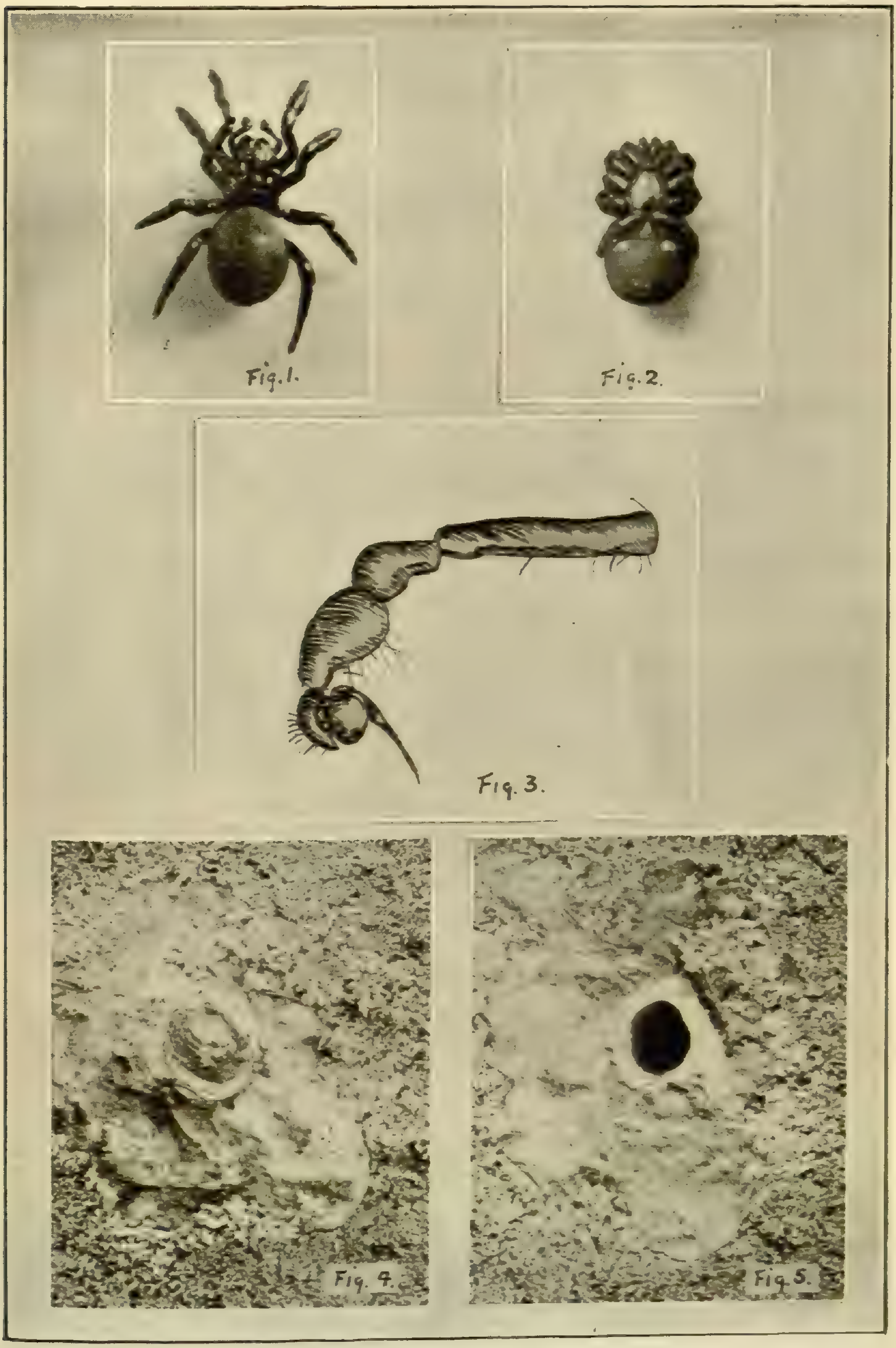

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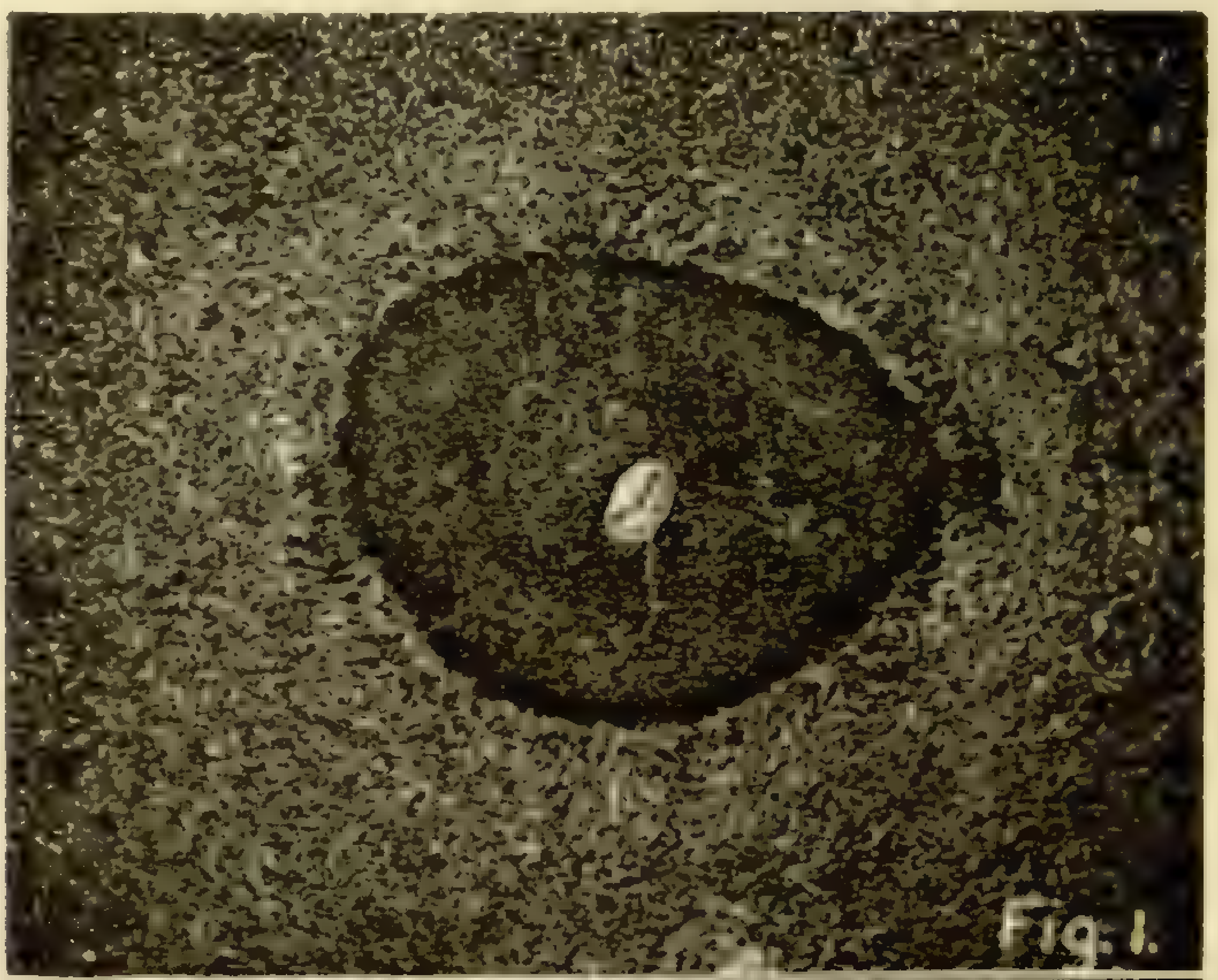

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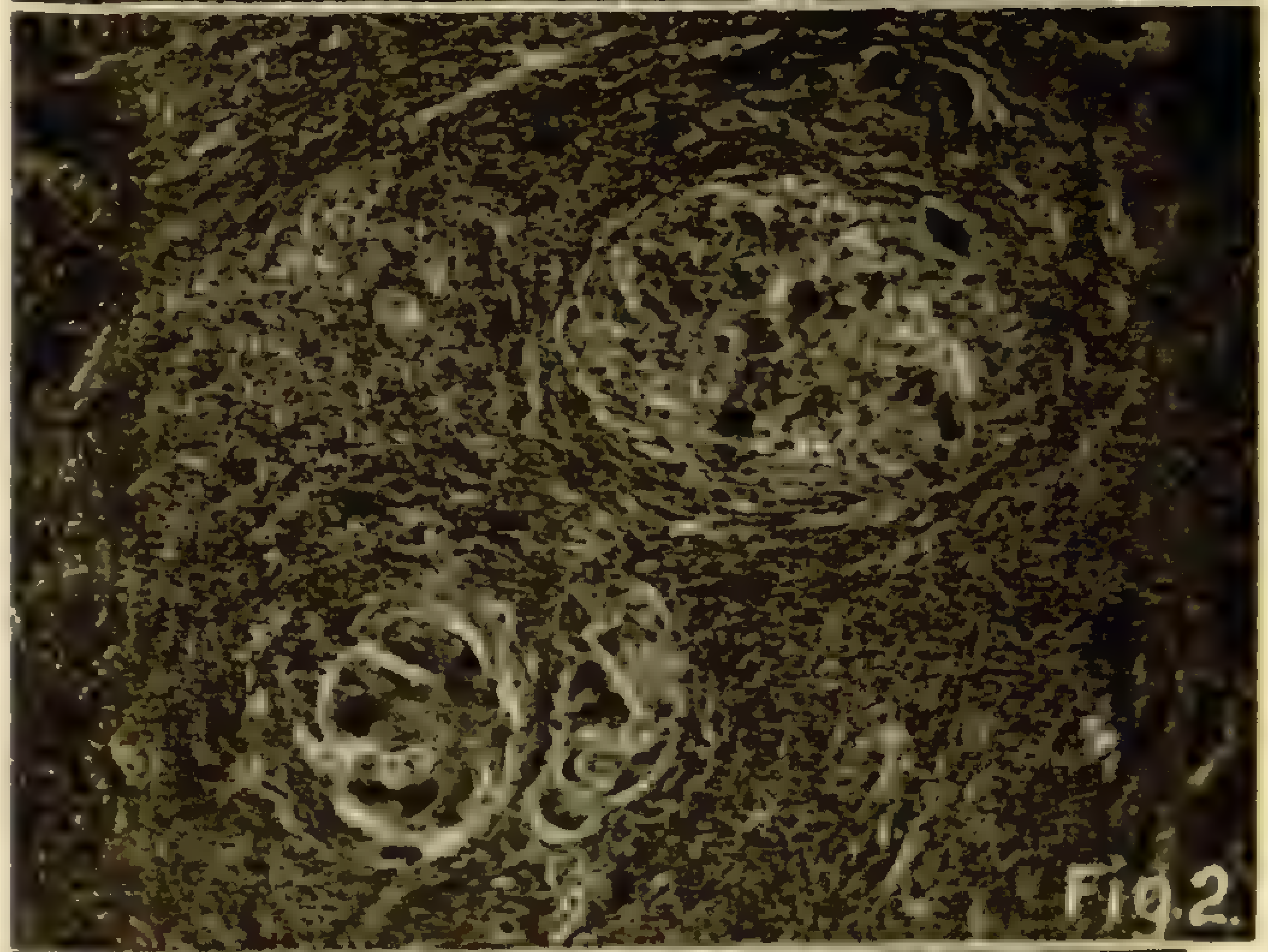

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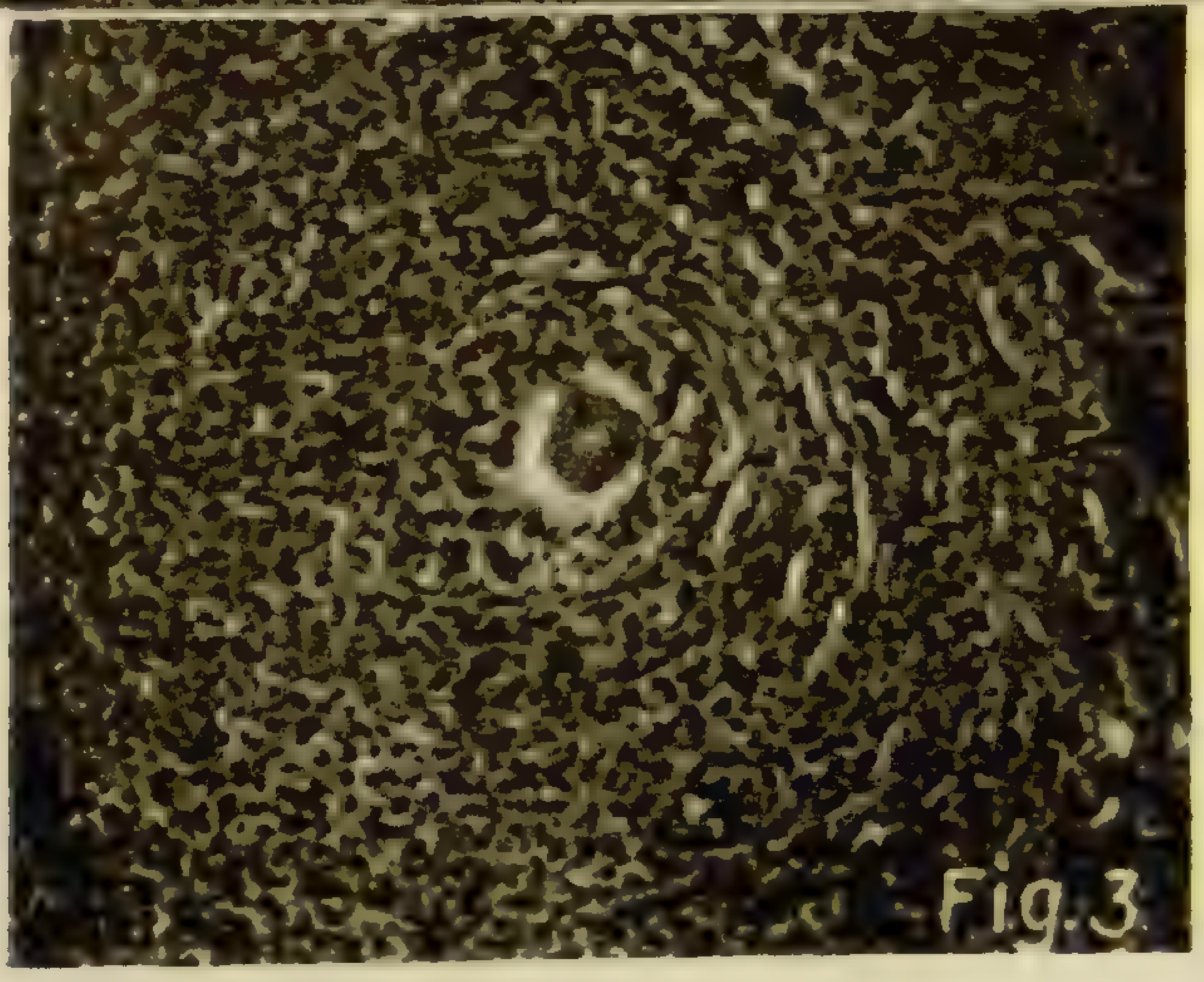

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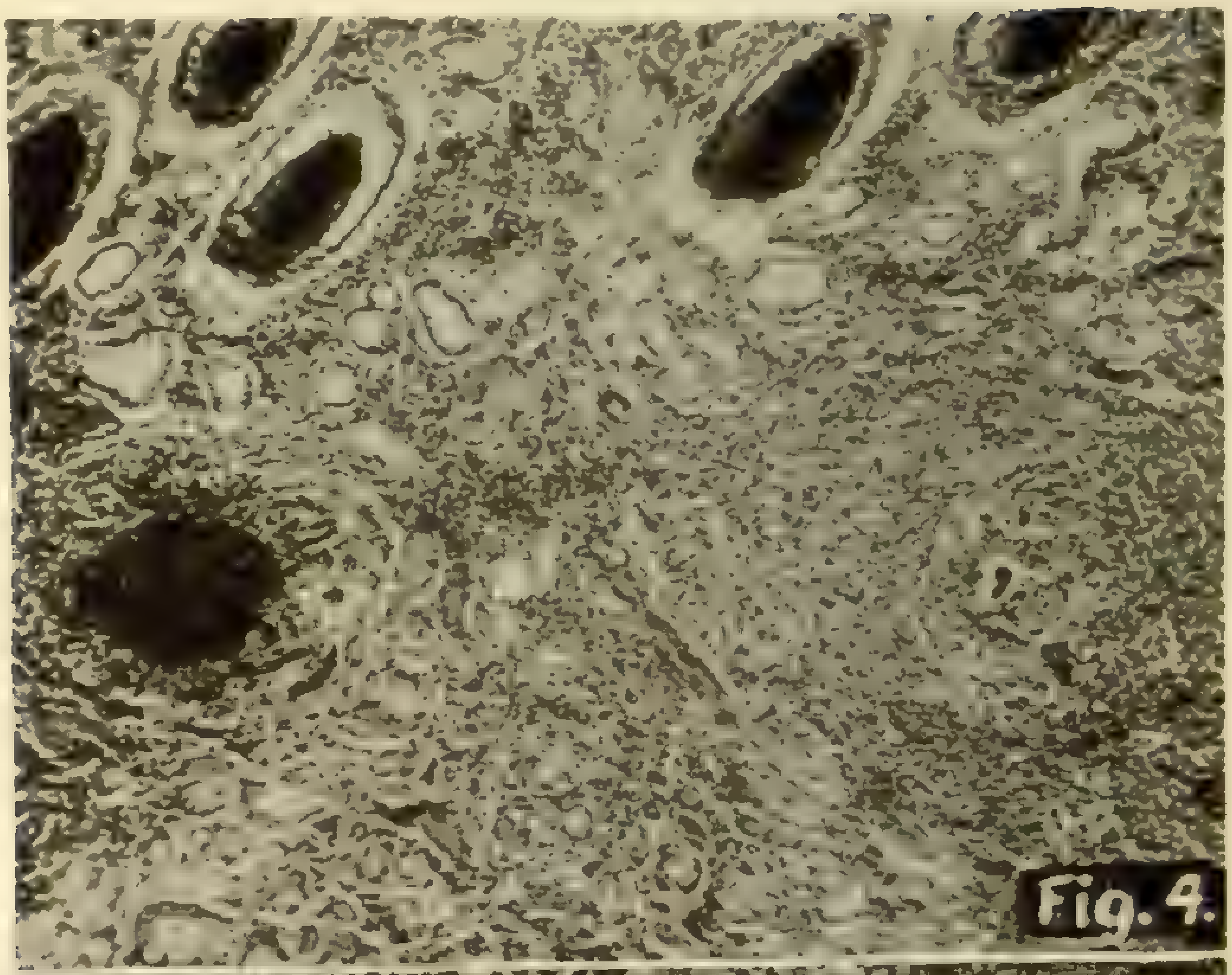

Fig. 4.

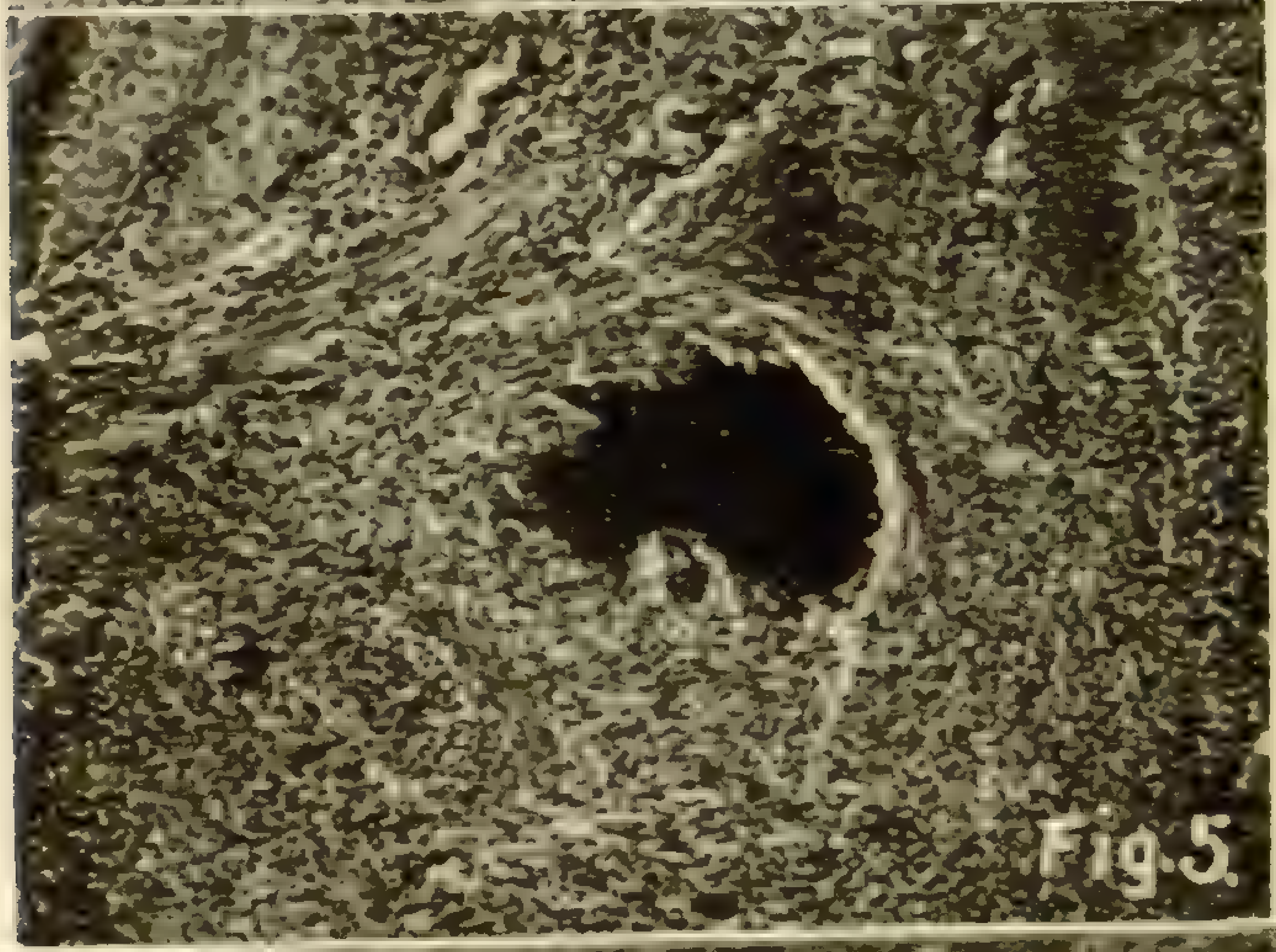

Fig. 5.

Fig. 6.

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Fig. 7.

Fig. 8.

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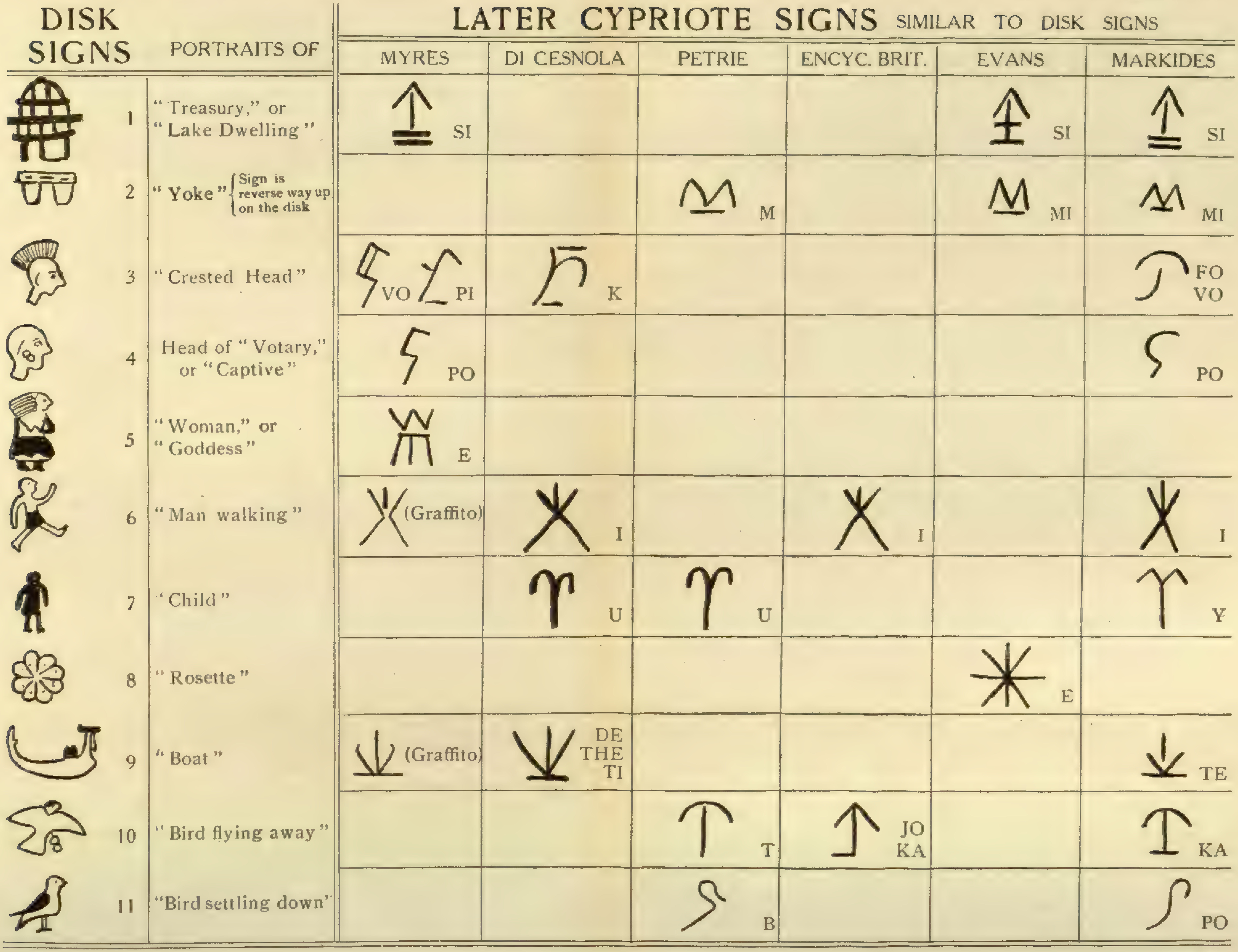

DISK SIGNS		PORTRAITS OF	LATER CYPRIOTE SIGNS SIMILAR TO DISK SIGNS: MYRES	DI CESNOLA	PETRIE	ENCYC. BRIT.	EVANS	MARKIDES
	1	"Treasury," or "Lake Dwelling"	SI				SI	SI
	2	"Yoke" {Sign is reverse way up on the disk}			M		MI	MI
	3	"Crested Head"	VO PI	K				FO VO
	4	Head of "Votary," or "Captive"	PO					PO
	5	"Woman," or "Goddess"	E					
	6	"Man walking"	(Graffito)	I		I		I
	7	"Child"		U	U			Y
	8	"Rosette"					E	
	9	"Boat"	(Graffito)	DE THE TI				TE
	10	"Bird flying away"			T	JO KA		KA
	11	"Bird settling down"			B			PO

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DISK SIGNS	PORTRAITS OF	LATER CYPRIOTE SIGNS SIMILAR TO DISK SIGNS: MYRES	DI CESNOLA	PETRIE	ENCYC. BRIT.	EVANS	MARKIDES
12	"Hide of some Animal"	(Graffito)	A				MA FA
13	"Archer's Glove"					Cypro-Minoan; KE Later Cypriote	KE
14	"Water"	(Graffito)	O U		NE		NE ZO
15	"Fortress"		E TO DO				FE
16	"Cat's Head"				SI		
17	"Bow"		EK	B			ZO
18	"Axe"		TA DA		TA	TA	TA
19	"Head of Wild Sheep, or Goat"		SI				MO
20	Uncertain		J		RA		JA RA
21	"Pillar"	NA				NA	NA

A. R. del.

DISK SIGNS	PORTRAITS OF	LATER CYPRIOTE SIGNS SIMILAR TO DISK SIGNS: MYRES	DI CESNOLA	PETRIE	ENCYC. BRIT.	EVANS	MARKIDES
22	"Plant," or "Tree"	(Graffito)				O O	O PA
23	"Pig's Head" (Hempl) "Leather Cutter" (Macalister)				RI		RI
24	"Bee," or "Moth"		OU				RO
25	"Fish"	(Graffito)	R				RA
26	"Lotus," or "Lily" (Hempl)			A	A		SE
27	"Phallic Organ"	(Graffito)	NA	PH			XE
28	"Mason's Square"	LE					LI
29	"Cypress Tree"		L(O)				
30	"Horn"		U		NE		
31	"Lunar Sign (?)"		KI				SU (Evidently Moon and Star)

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DISK SIGNS		PORTRAITS OF	LATER CYPRIOTE SIGNS SIMILAR TO DISK SIGNS: MYRES	DI CESNOLA	PETRIE	ENCYC. BRIT.	EVANS	MARKIDES
	32	"Wind Instrument (?)" = Pipes	(Graffiti)	S				SA
	33	"Cap (?)"		GO				RE
	34	"Hoof"		S	S			SE
	35	"Dagger in Case"			V			VO
	36	"Pipes (?)"		KO	G	KO	KO	KO KO

DISK SIGNS POSSESSING NO SATISFACTORY RESEMBLANCE TO THE LATER CYPRIOTE SIGNS.

SIGNS		PORTRAITS OF	SIGNS		PORTRAITS OF	SIGNS		PORTRAITS OF	
	37	"Cypriote Cap of period of Assyrian influence"		40	"Thistle"		43	"Tree"	Supposed Virama-mark :–
	38	"Shield (?) of period of Assyrian influence"		41	"Ring" (see Brit. Mus., "Evcavations in Cyprus")		44	"Bone"	
	39	"Jug"		42	"Captive"		45	"Arrow." Perhaps "Oar." See "Anc. Hist. Near East" (Hall), Pl. XXVII. (Phoenician warship)	

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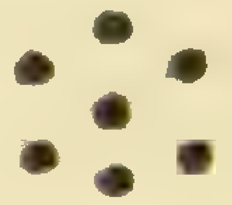
MISCELLANEOUS EQUATIONS.

From Phaestos Disk.	From "Catalogue of Cyprus Museum" J. L. Myres.
SIGN NO. 6 (MAN):	On Cypriote scarab of Late Iron Age (Plate VIII.).
SIGN NO. 38 (SHIELD):	(a) On lenticular bead of Late Iron Age (p.136). (b)  Dotted ornament on figure of Hellenistic Age (p.92). (c) Painted shield held by warrior (p.151).
WORDS 14, 20, 53, & 60:	Compare the Cypriote graffiti (reading from left to right) on Vases Nos. 1952 & 1954 (p.90):- (1) NA-O-TE: (2) NA-O-TE:

A TYPICAL INSCRIPTION IN LATER CYPRIOTE CHARACTERS, WITH TRANSLITERATION, ETC.
(From "Handbook of Cesnola Collection," Myres, p.392).

E. TE. VA. DO. RO: TO: PA. PO: BA. SI. LE. VO. SE: =

Ἐτεάνδρου τοῦ Πάφου βασιλέως,

i.e., "Of Eteandros the king of Paphos."

A. ROWE. del.

Fig. 1.

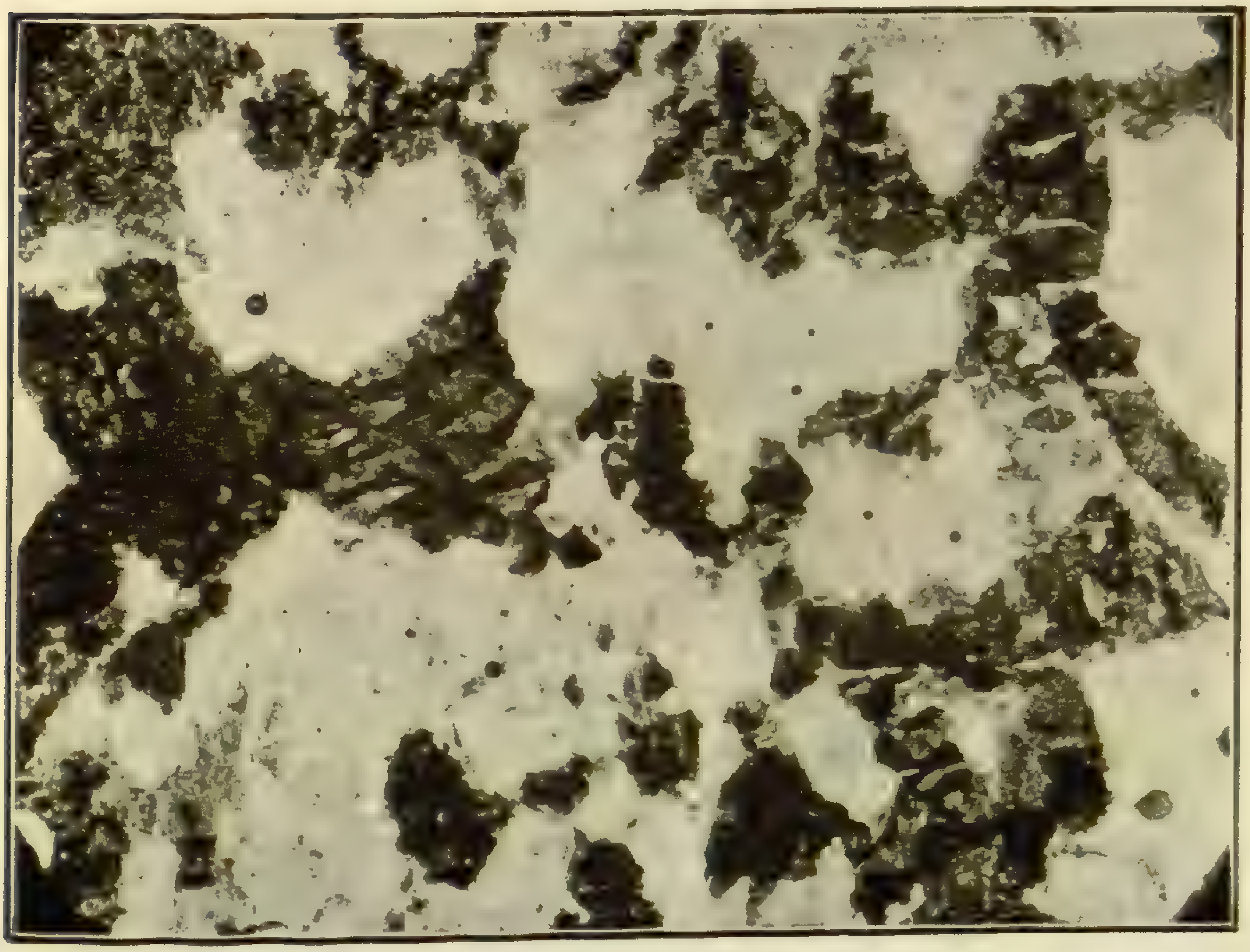


Fig. 2.

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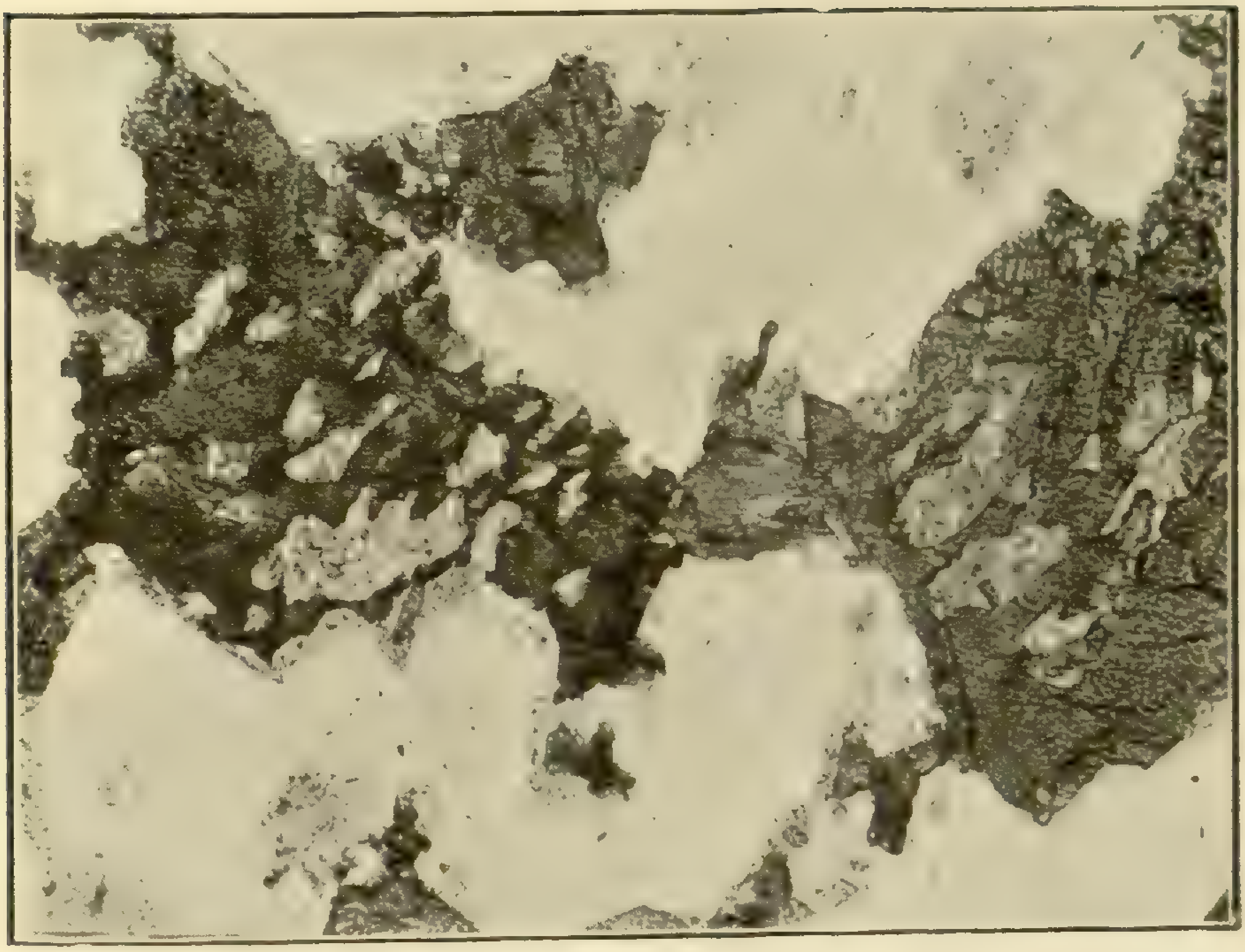

Fig. 1.

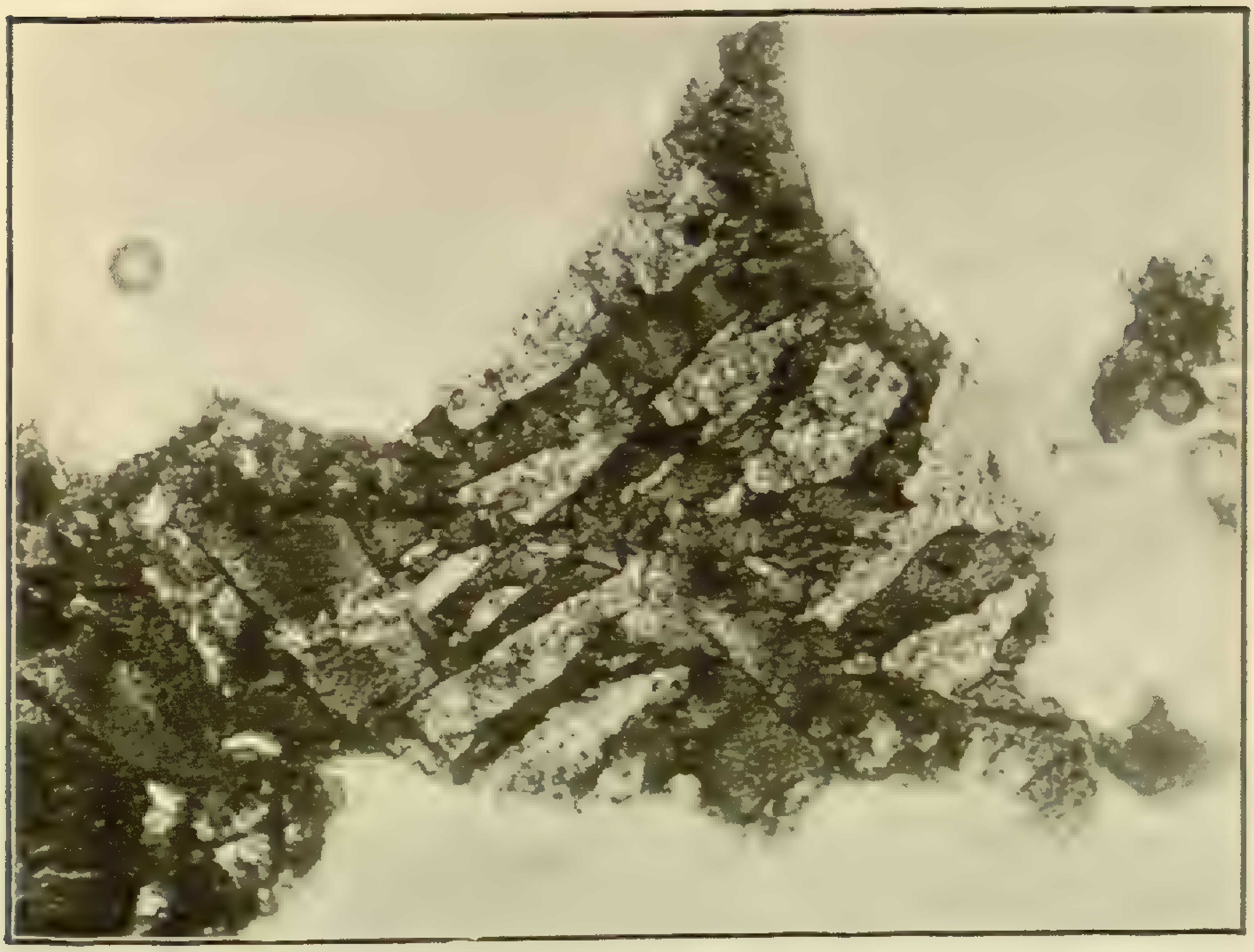

Fig. 2.

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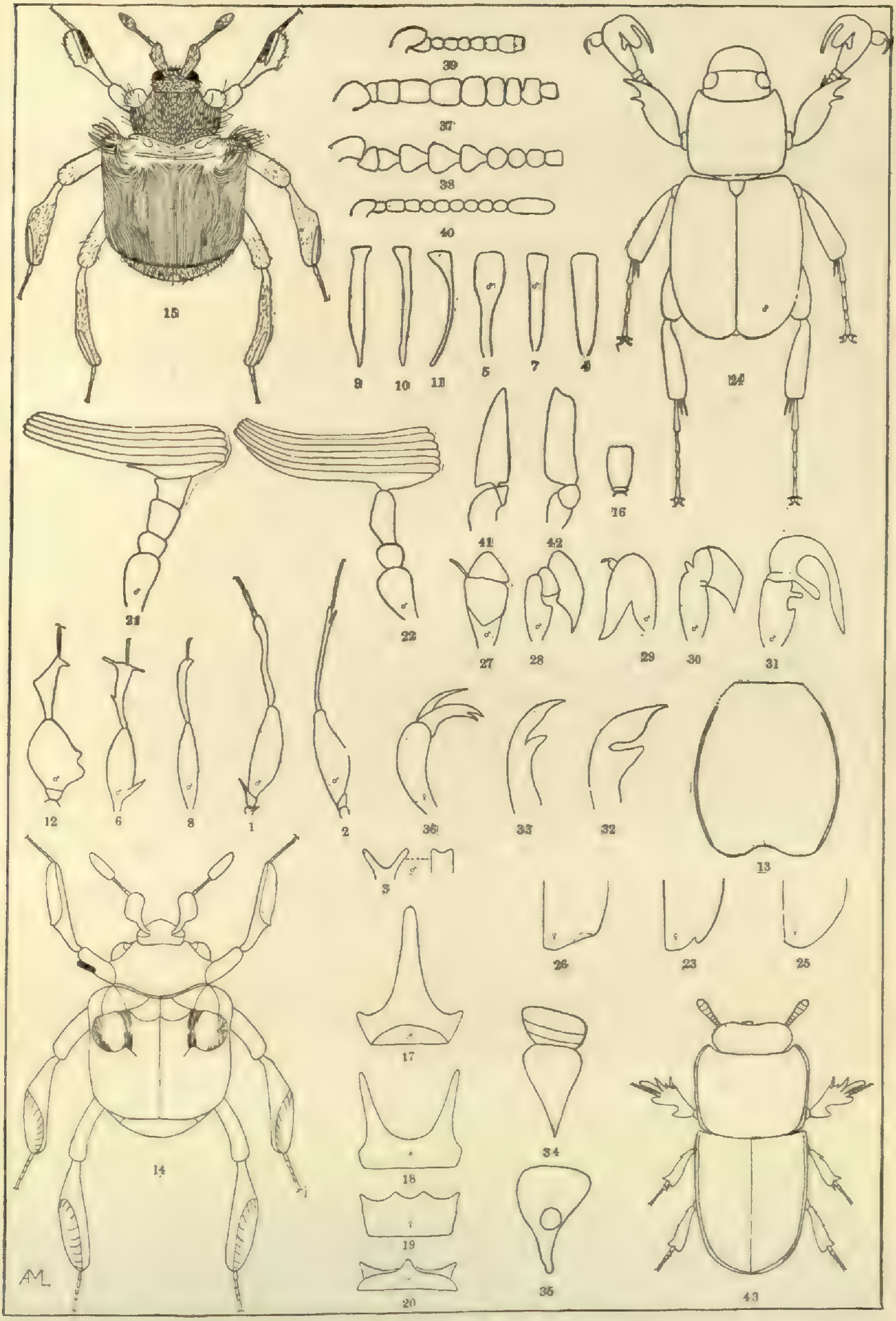

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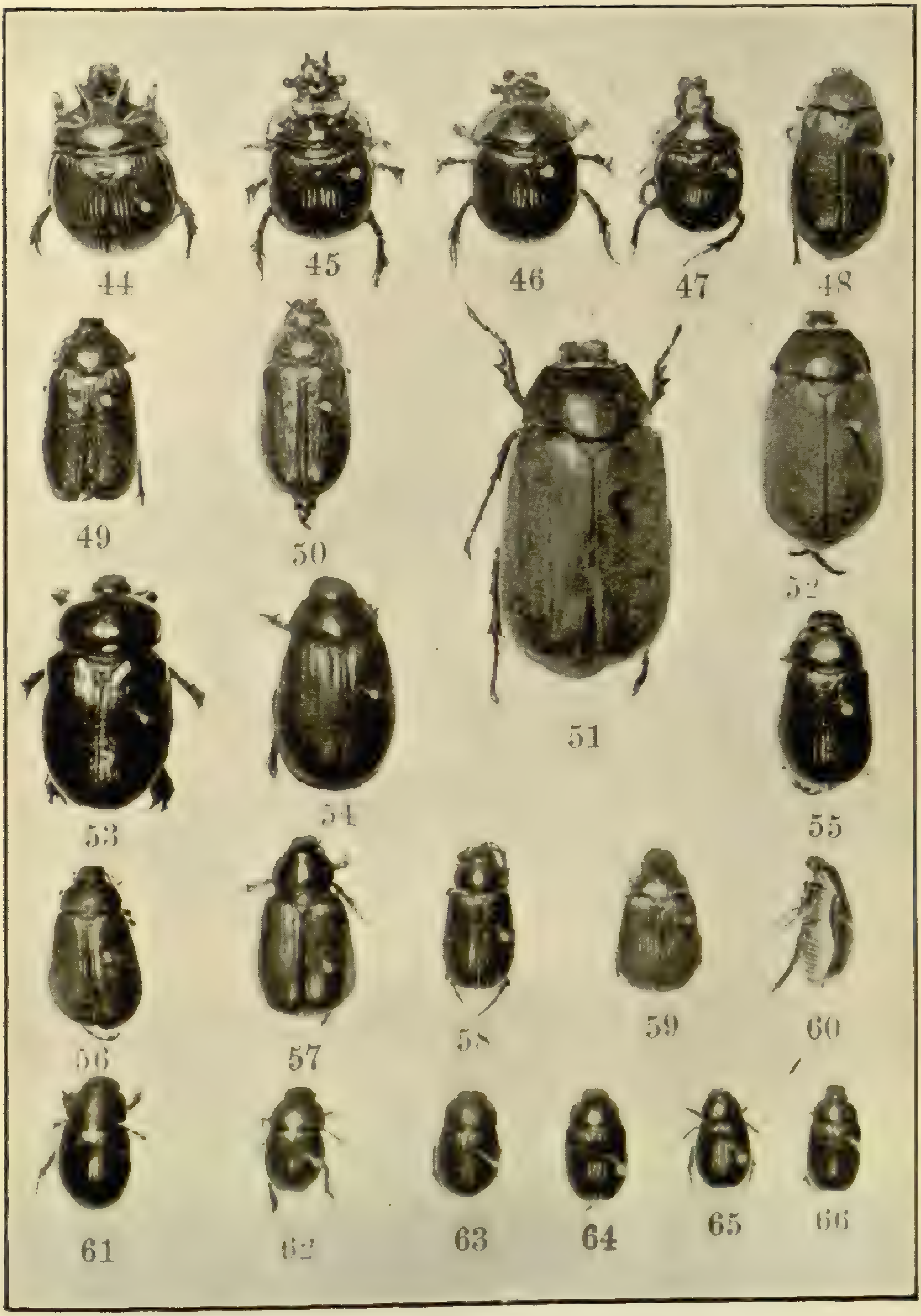

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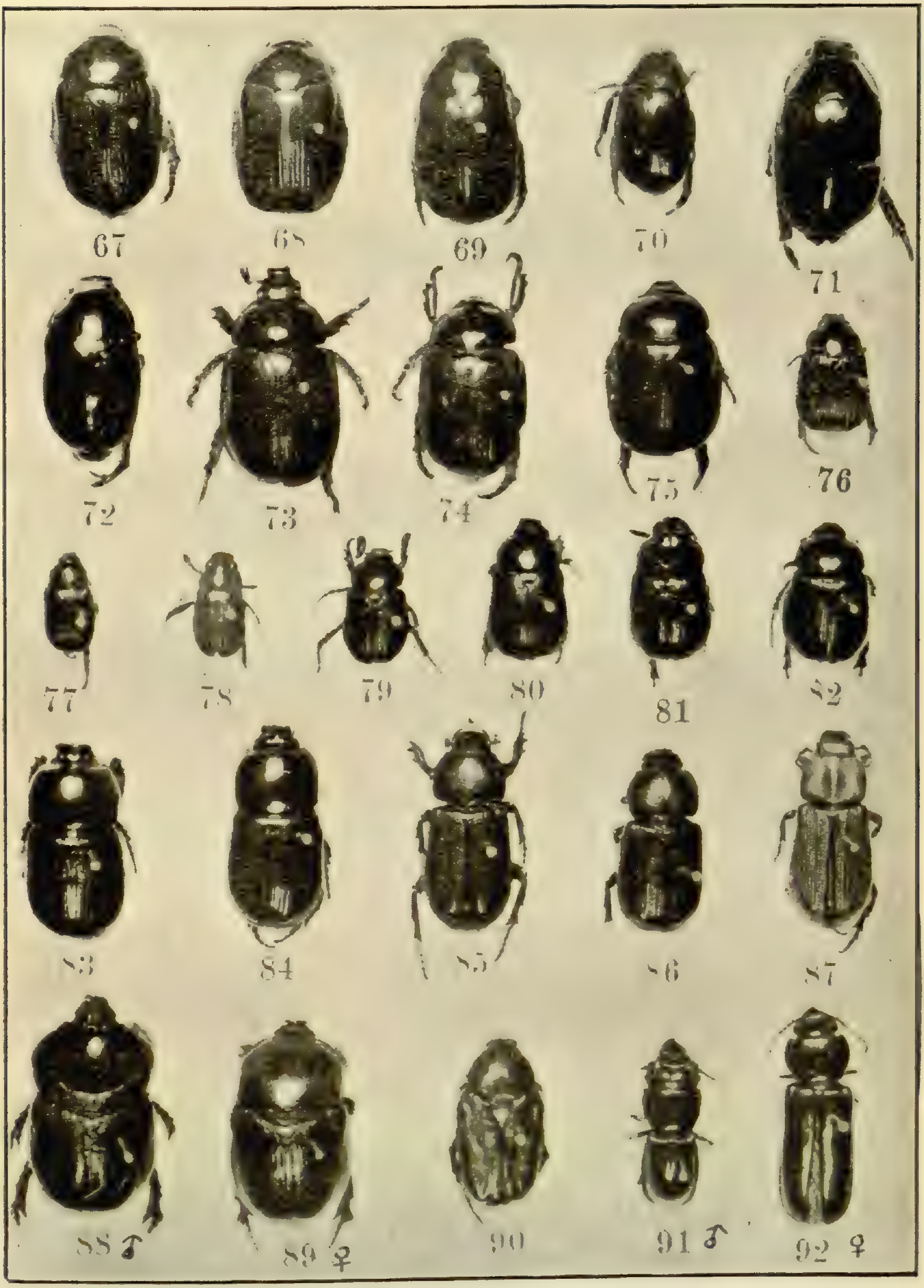

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Phyllis F. Clarke.

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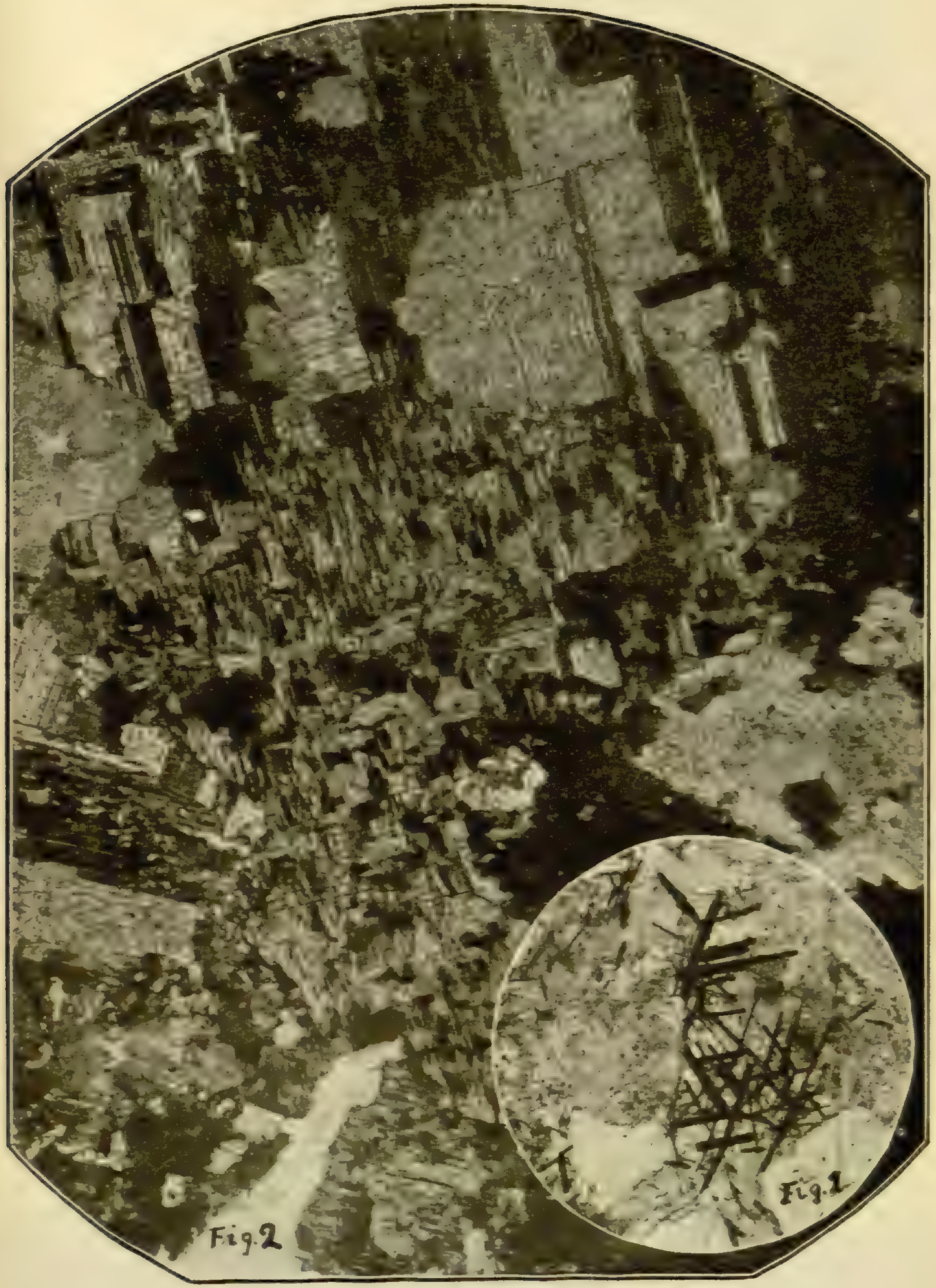

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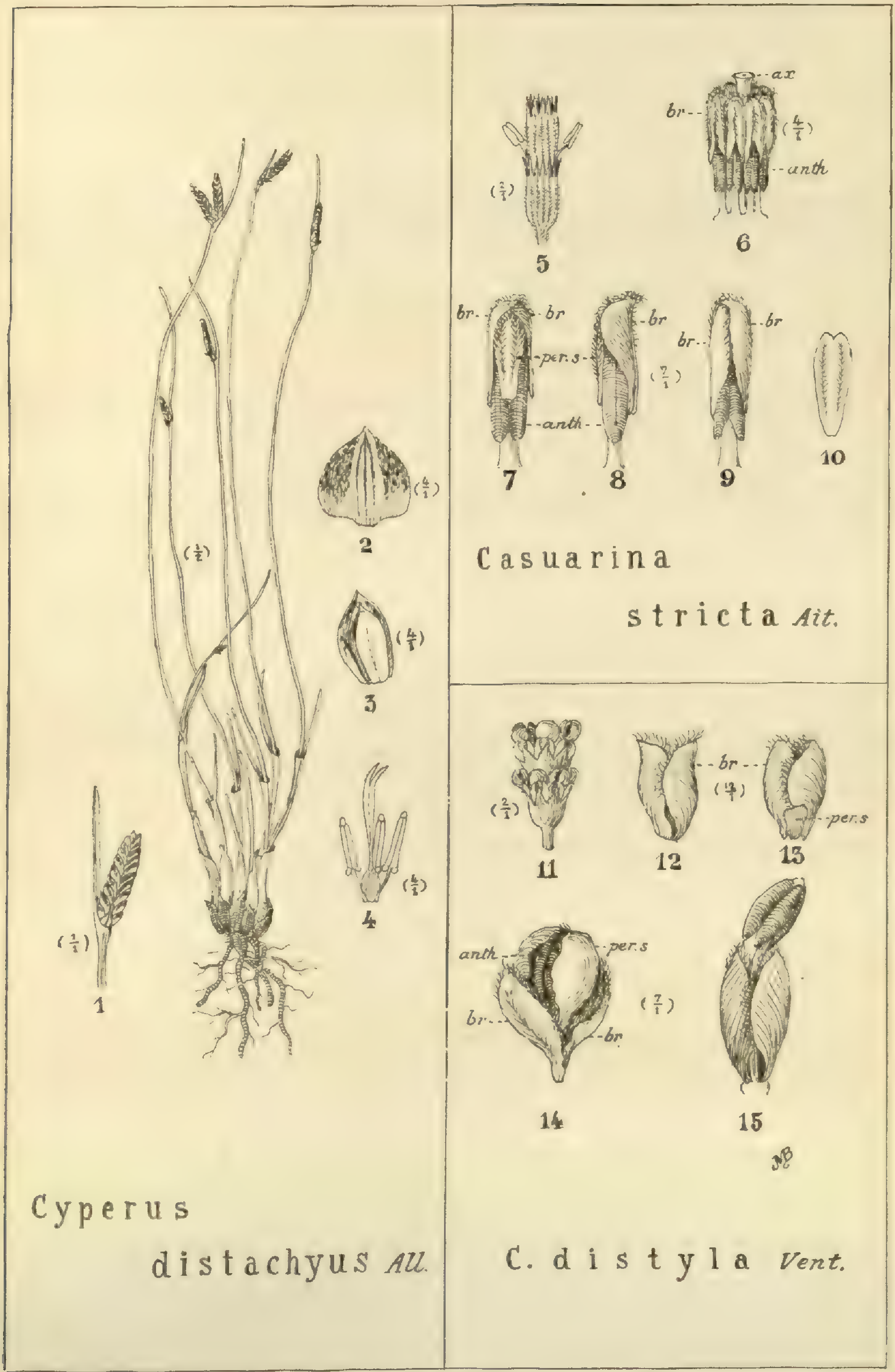

Cyperus distachyus *All.*

Casuarina stricta *Ait.*

C. distyla *Vent.*

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A. halocnemoides *Nees* *var.* pergranulatum *n. var.*

Arthrocnemum halocnemoides *Nees*

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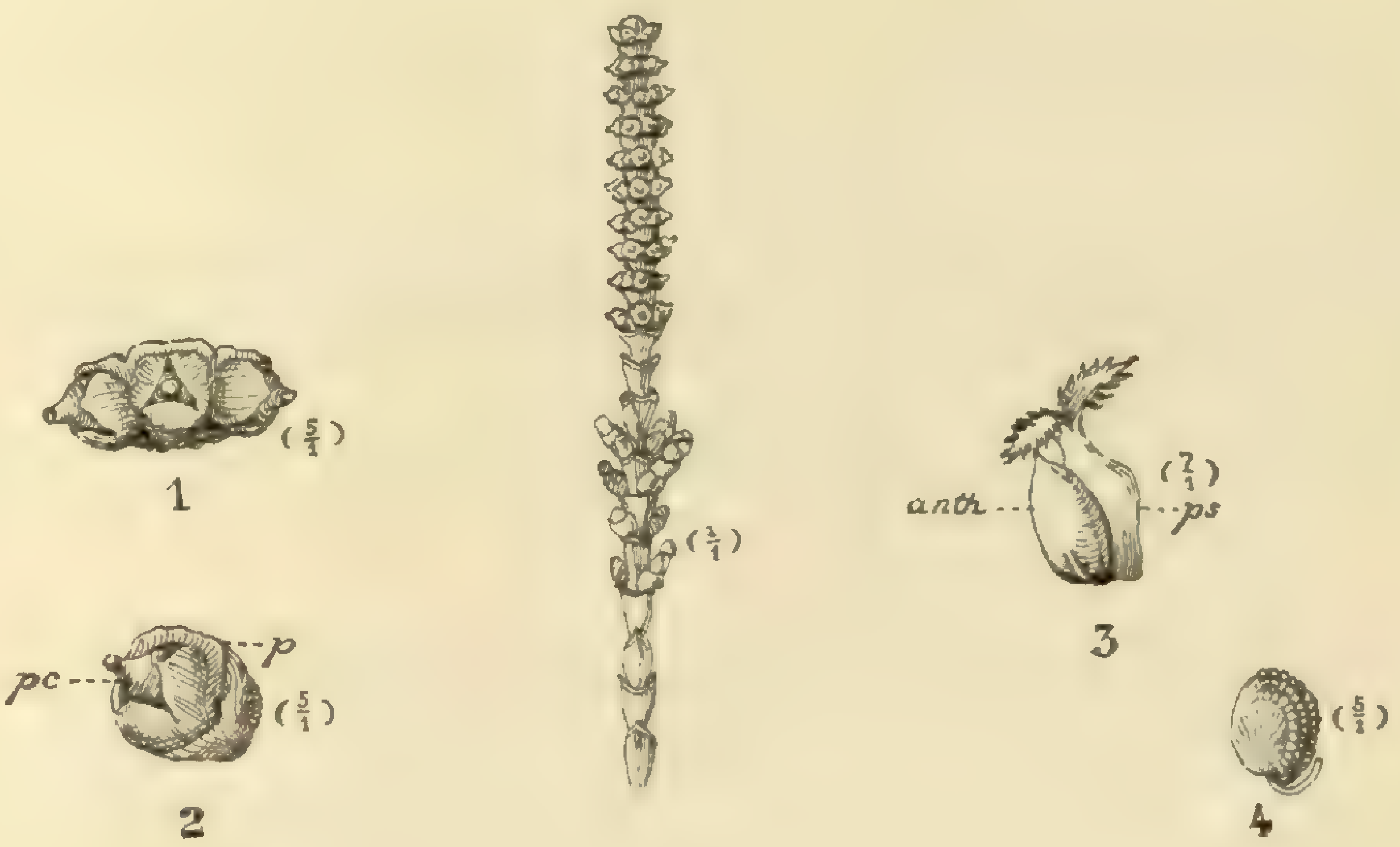

Arthrocnemum Lylei (*Ew. et White*) *comb. n.*

Arthrocnemum bidens *Nees*

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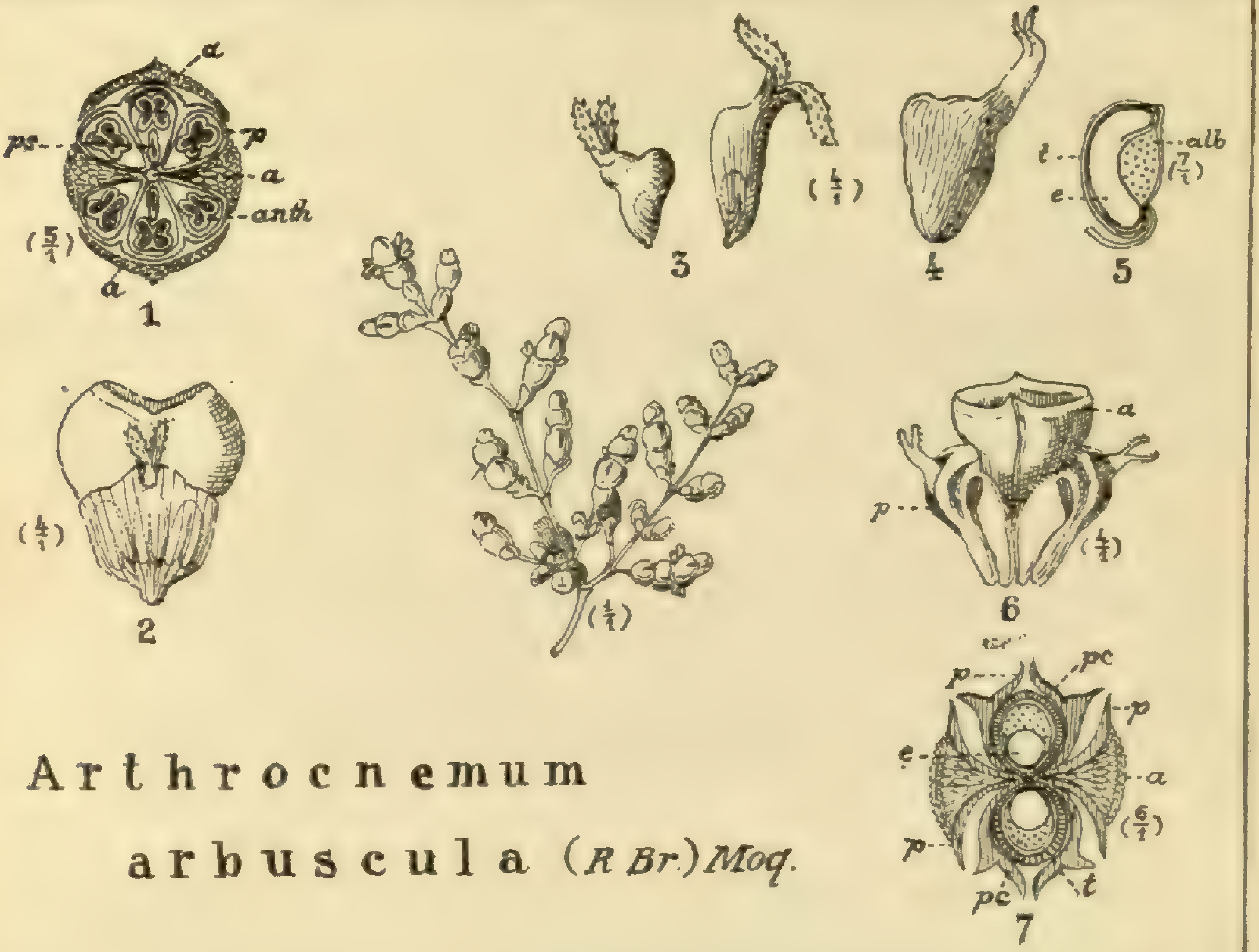
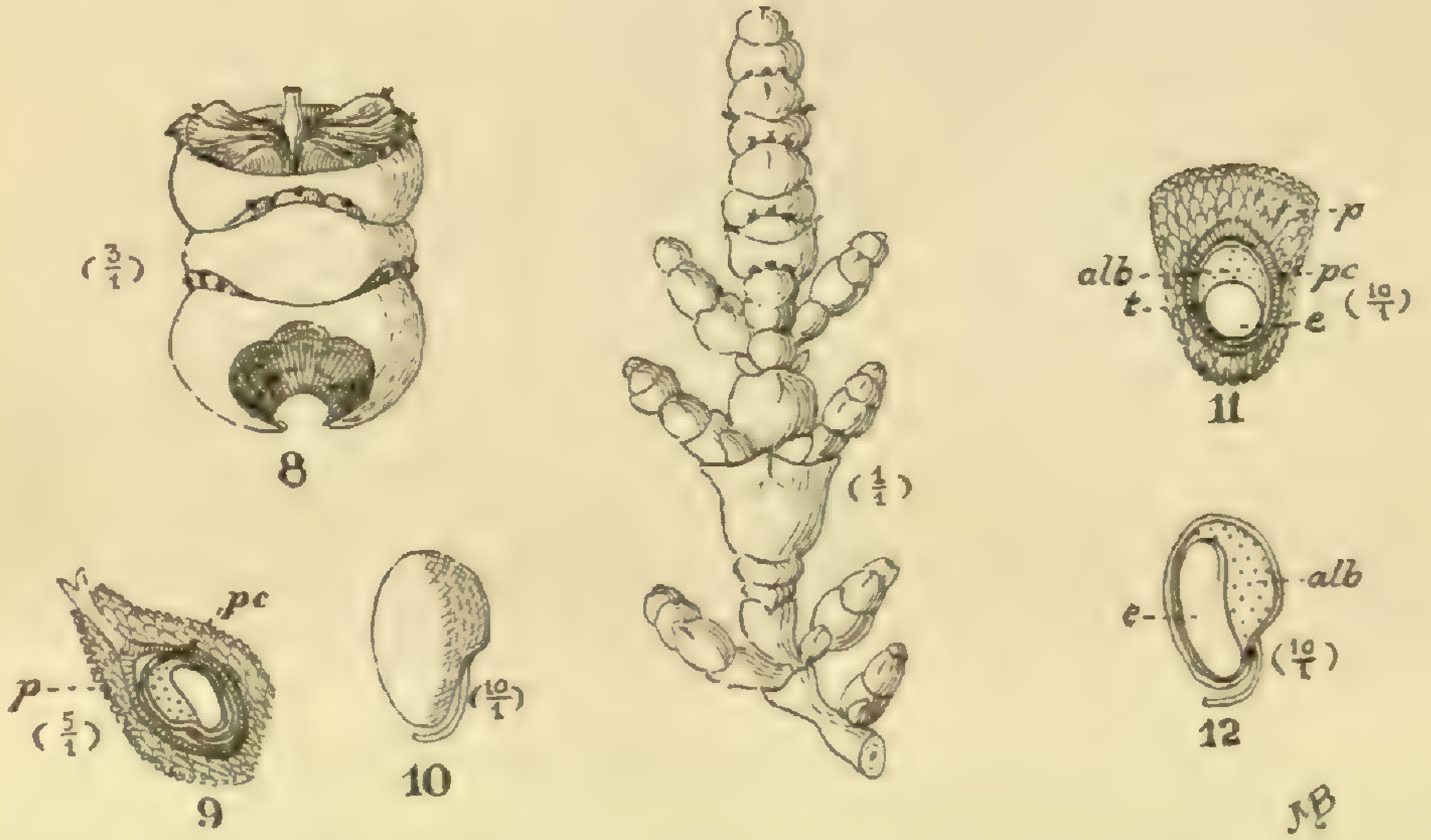


Arthrocnemum arbuscula (R Br.) Moq.



Arthrocnemum leiostachyum (Bth) Paulsen

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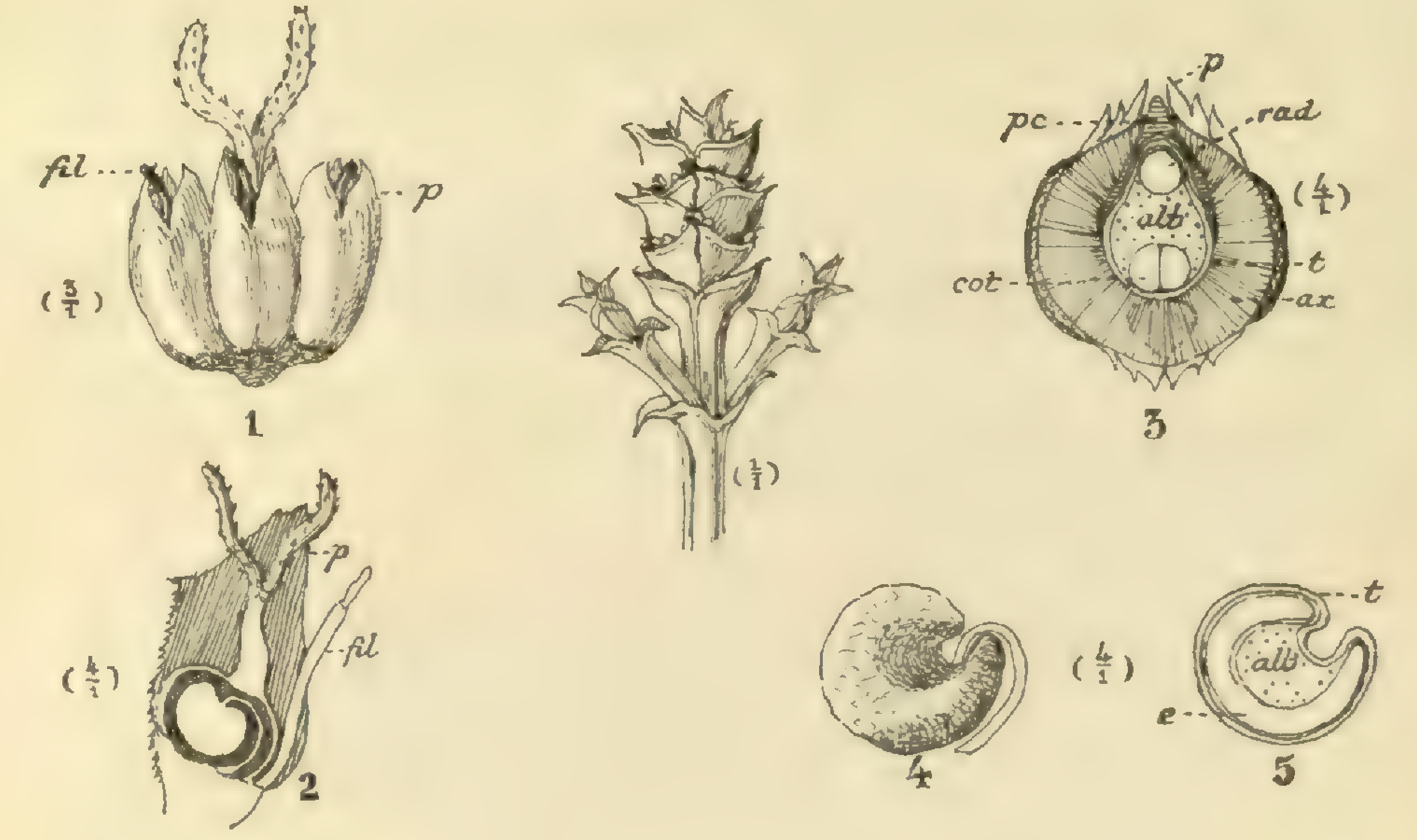
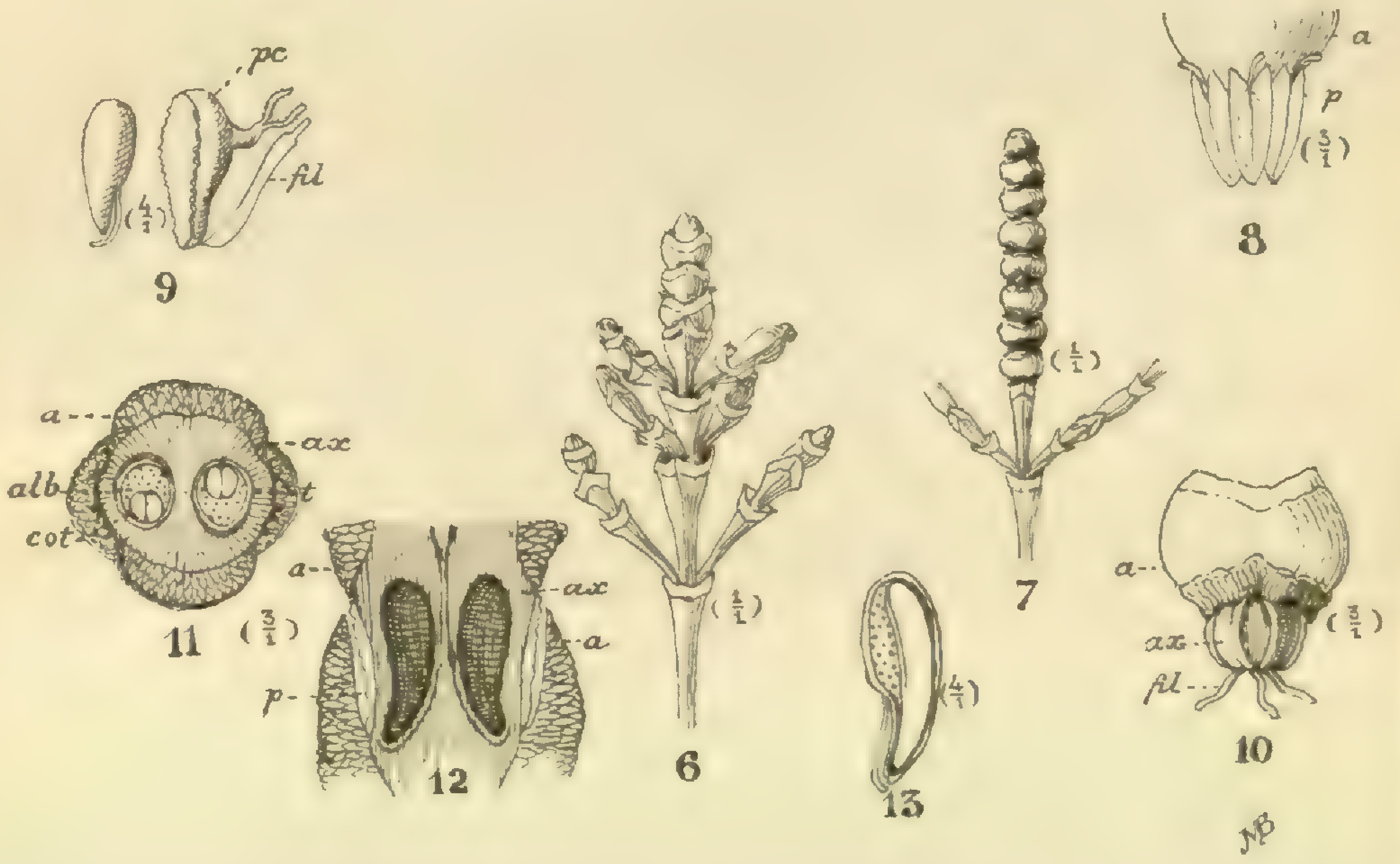


Pachycornia robusta (F.v.M.) Hook. f.



Pachycornia tenuis (Benth.) comb. nov.

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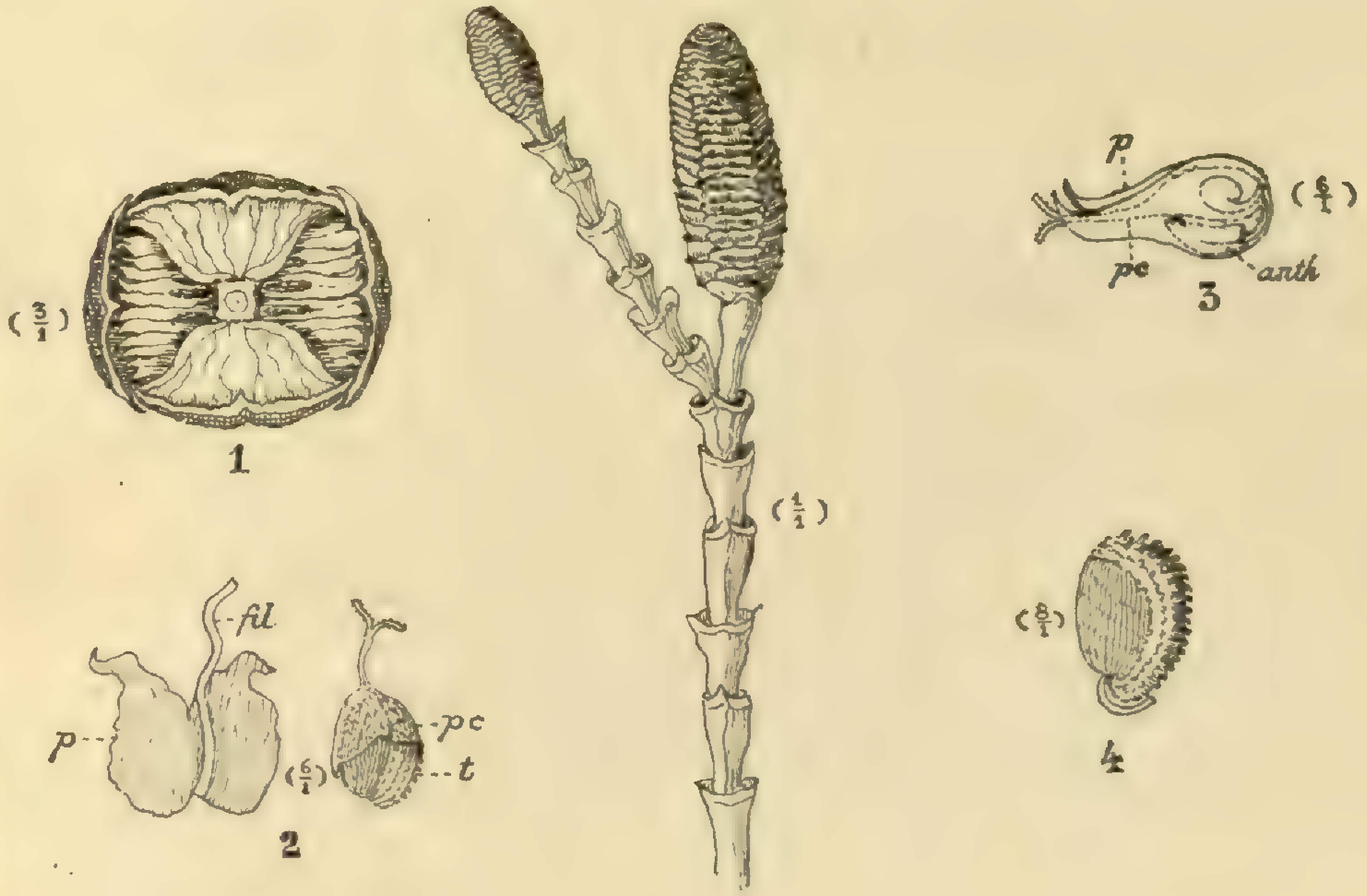

Tecticornia cinerea (F. v. M.) Hook. f.

Salicornia australis Banks et Sol.

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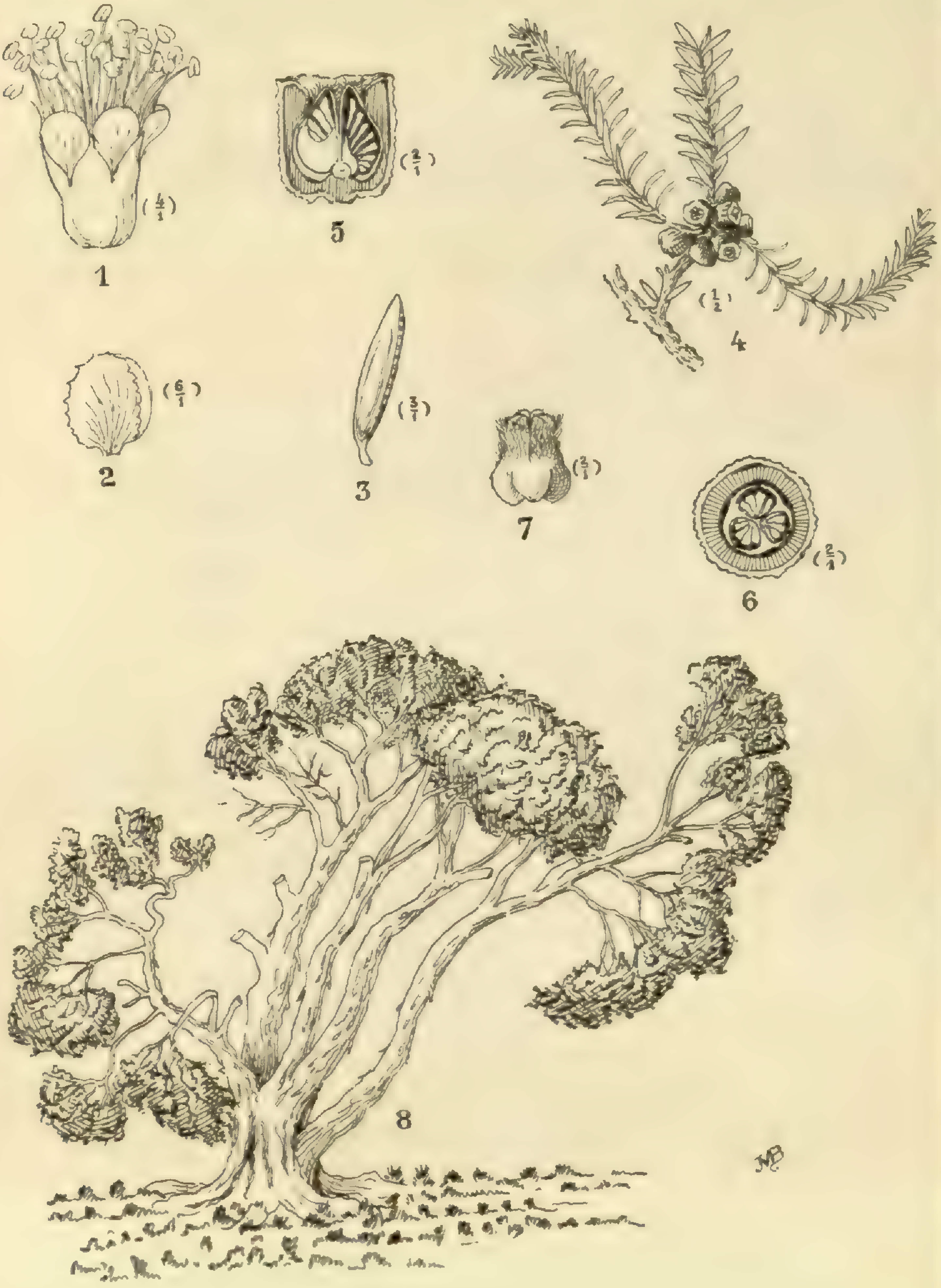

Melaleuca halmaturorum
F. v. M.

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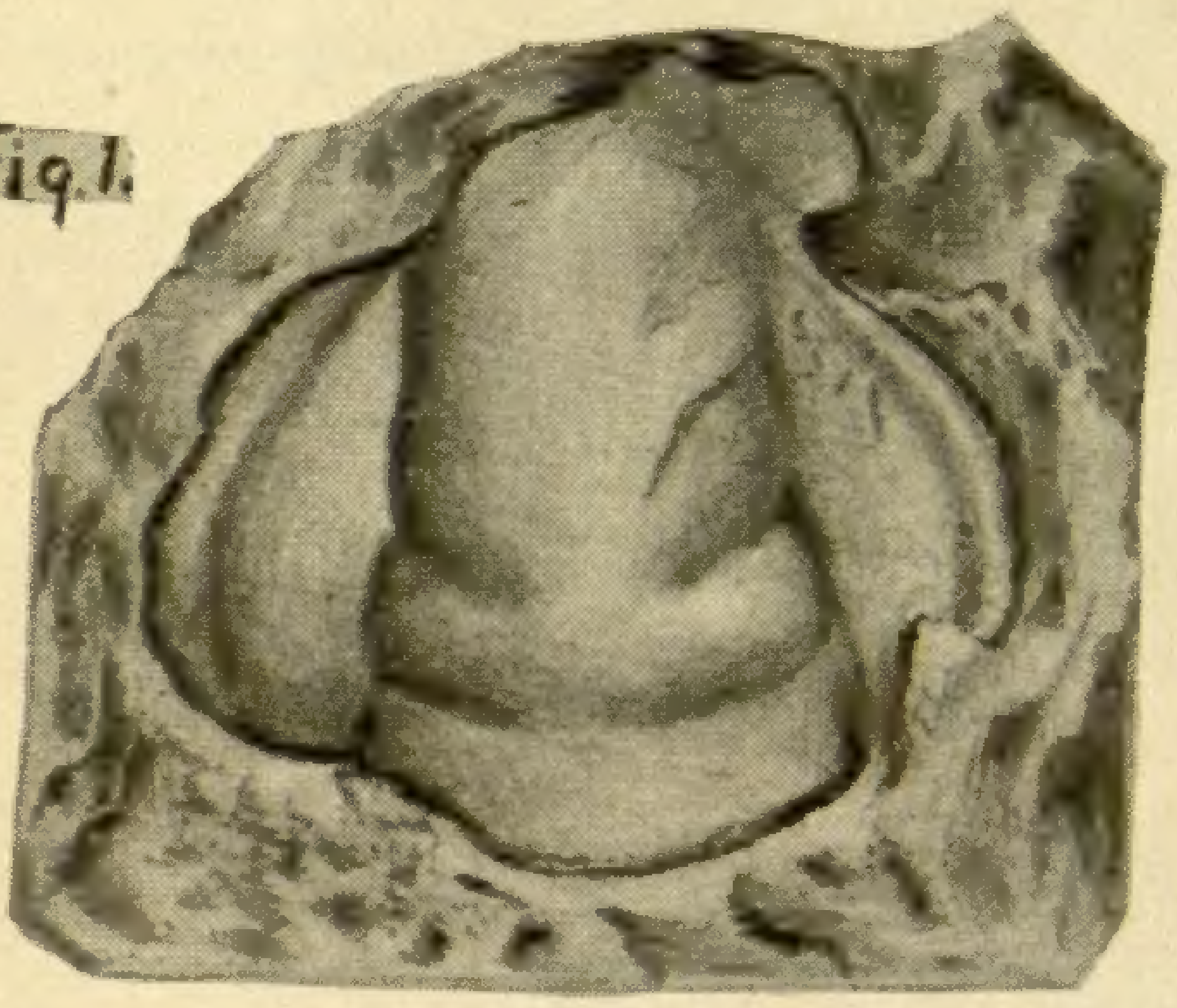
Fig. 1.



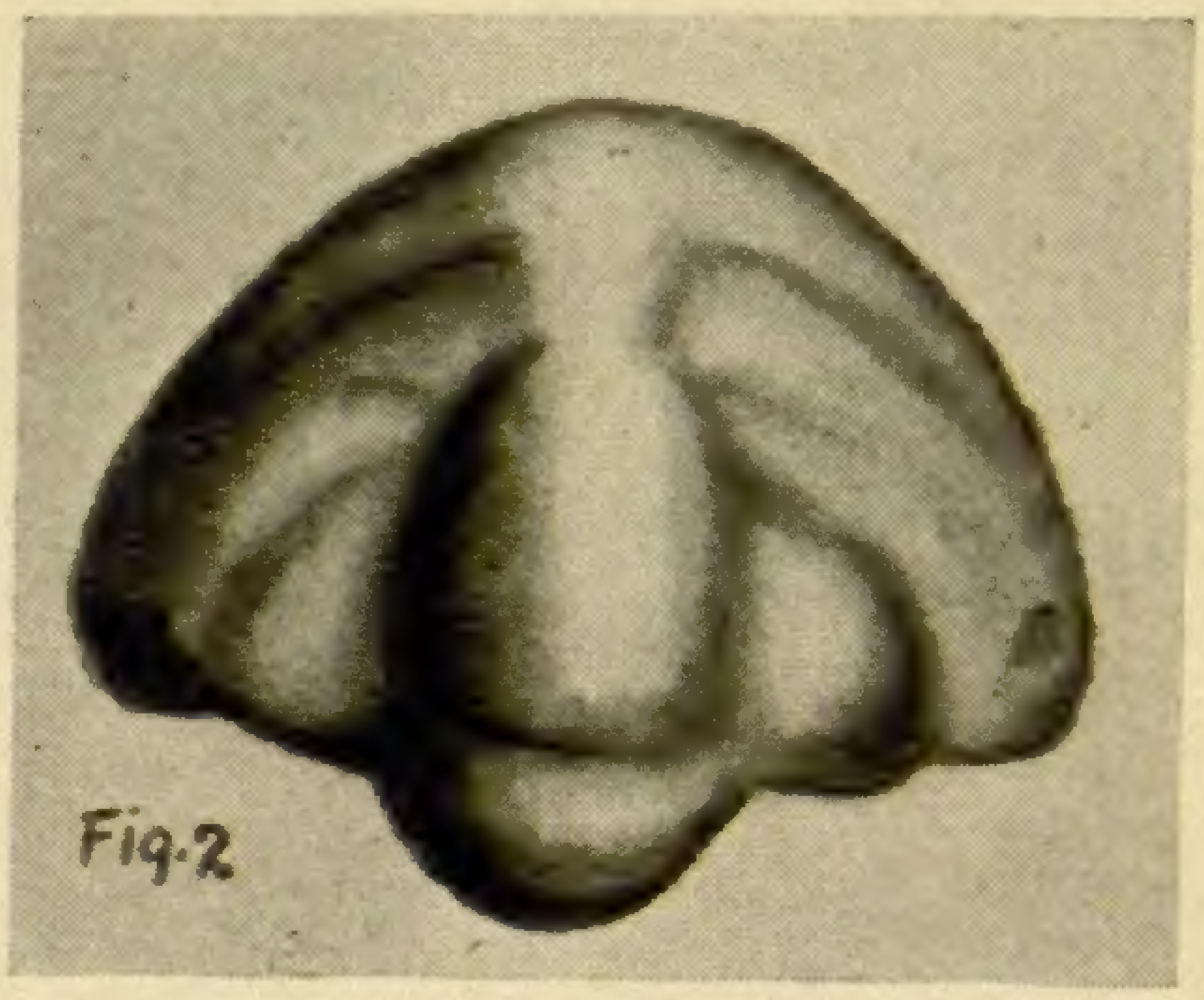


Fig. 2

Fig. 3.

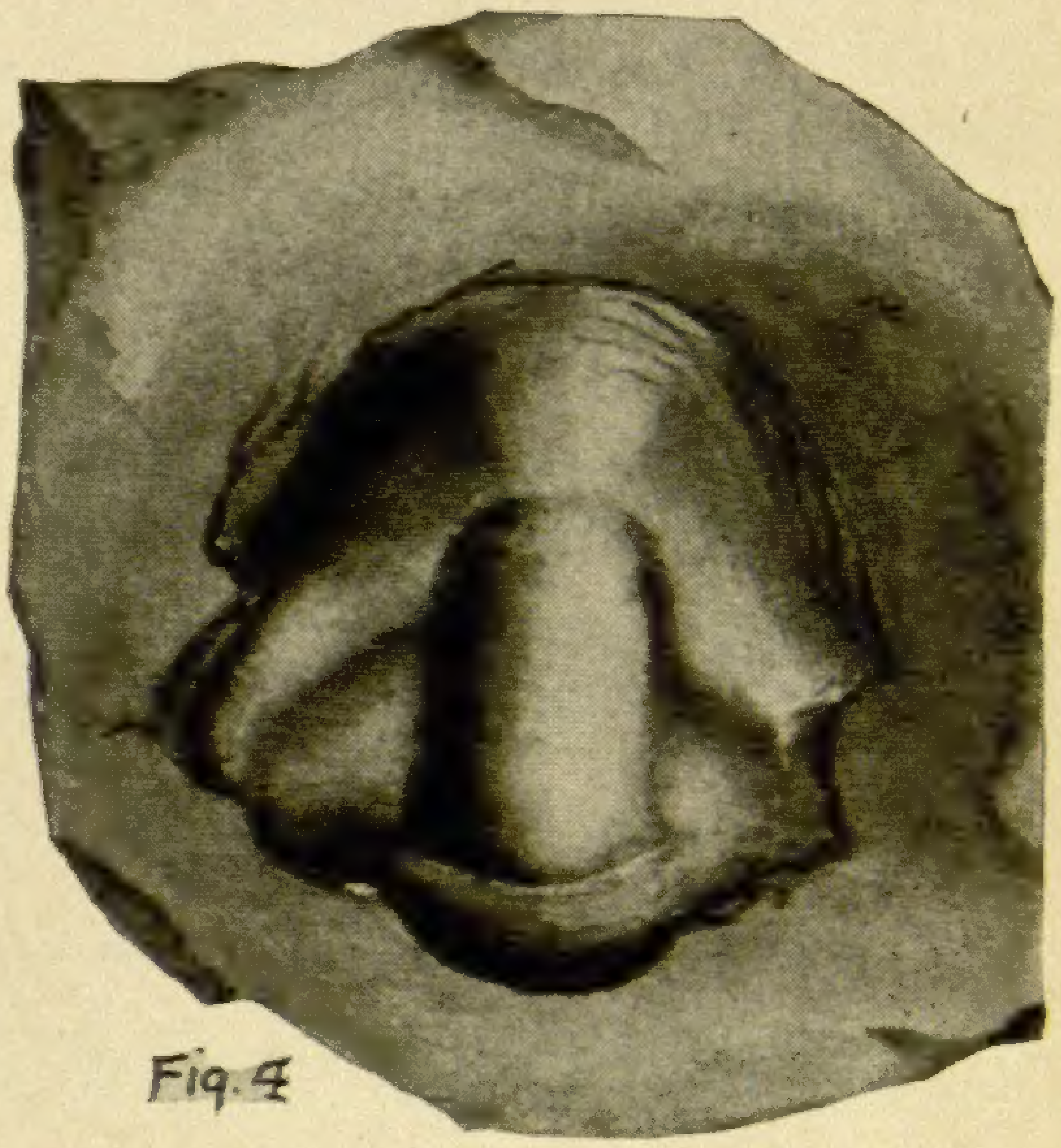
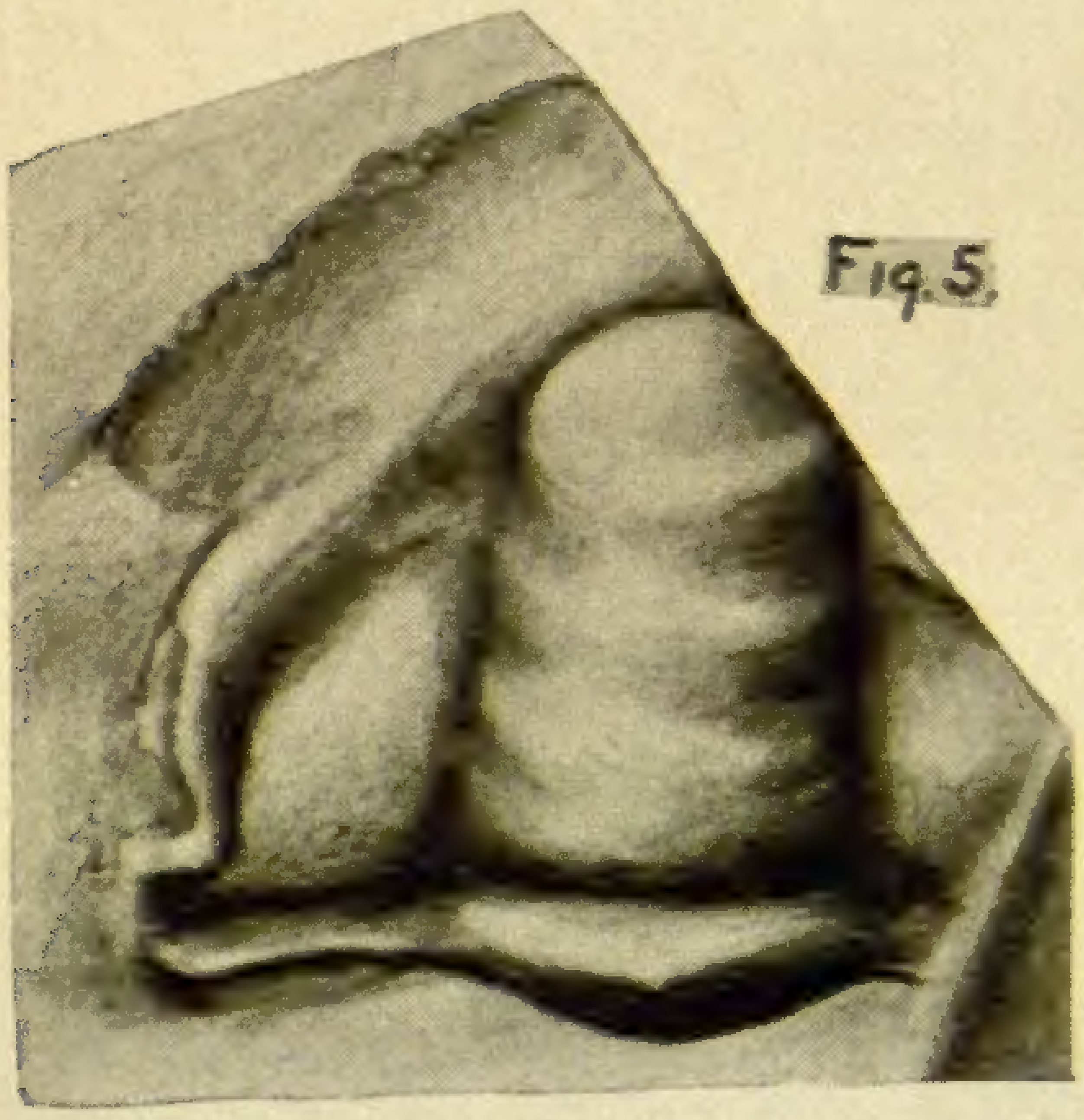


Fig. 4

Fig. 5.



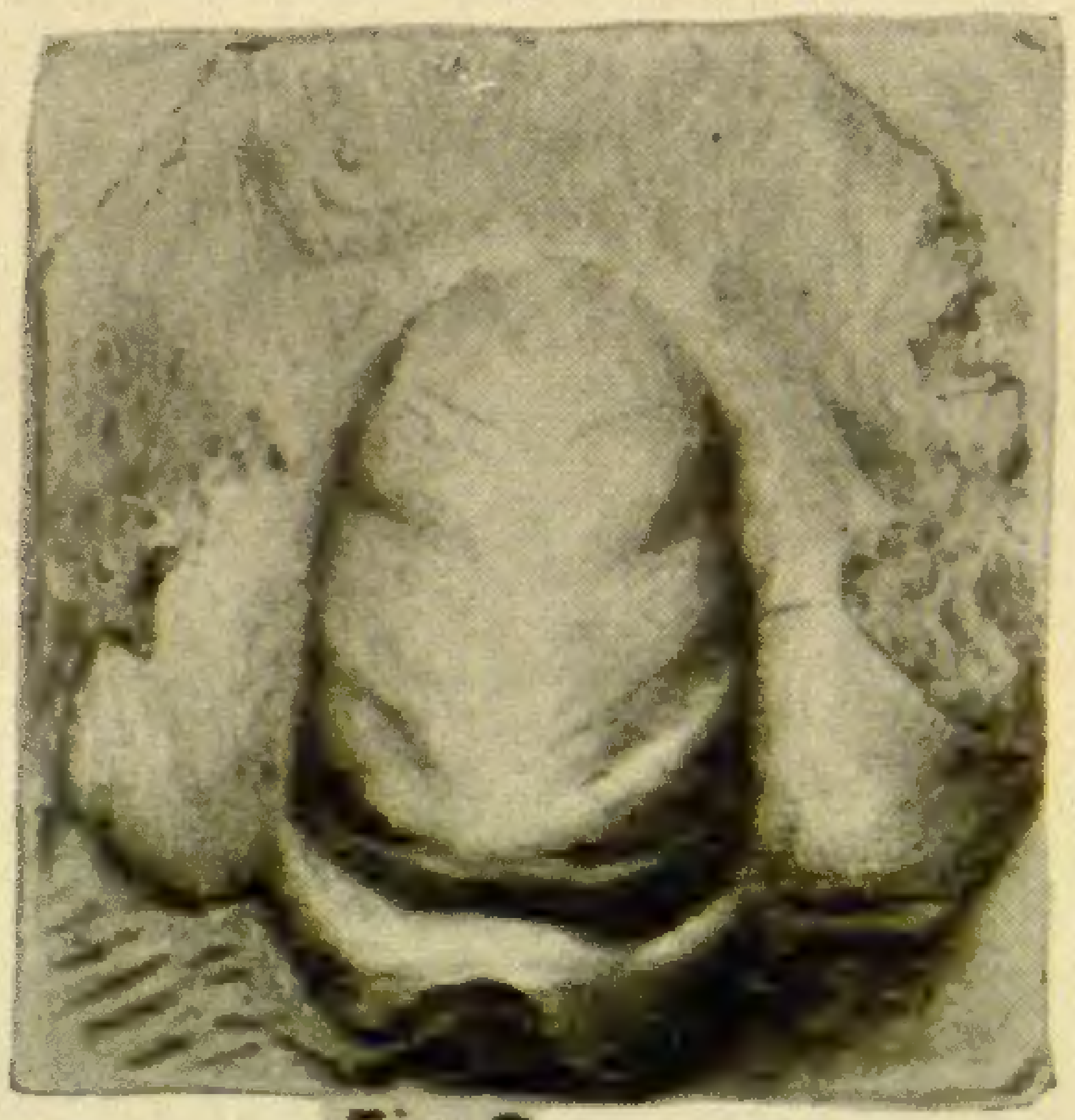


Fig. 6

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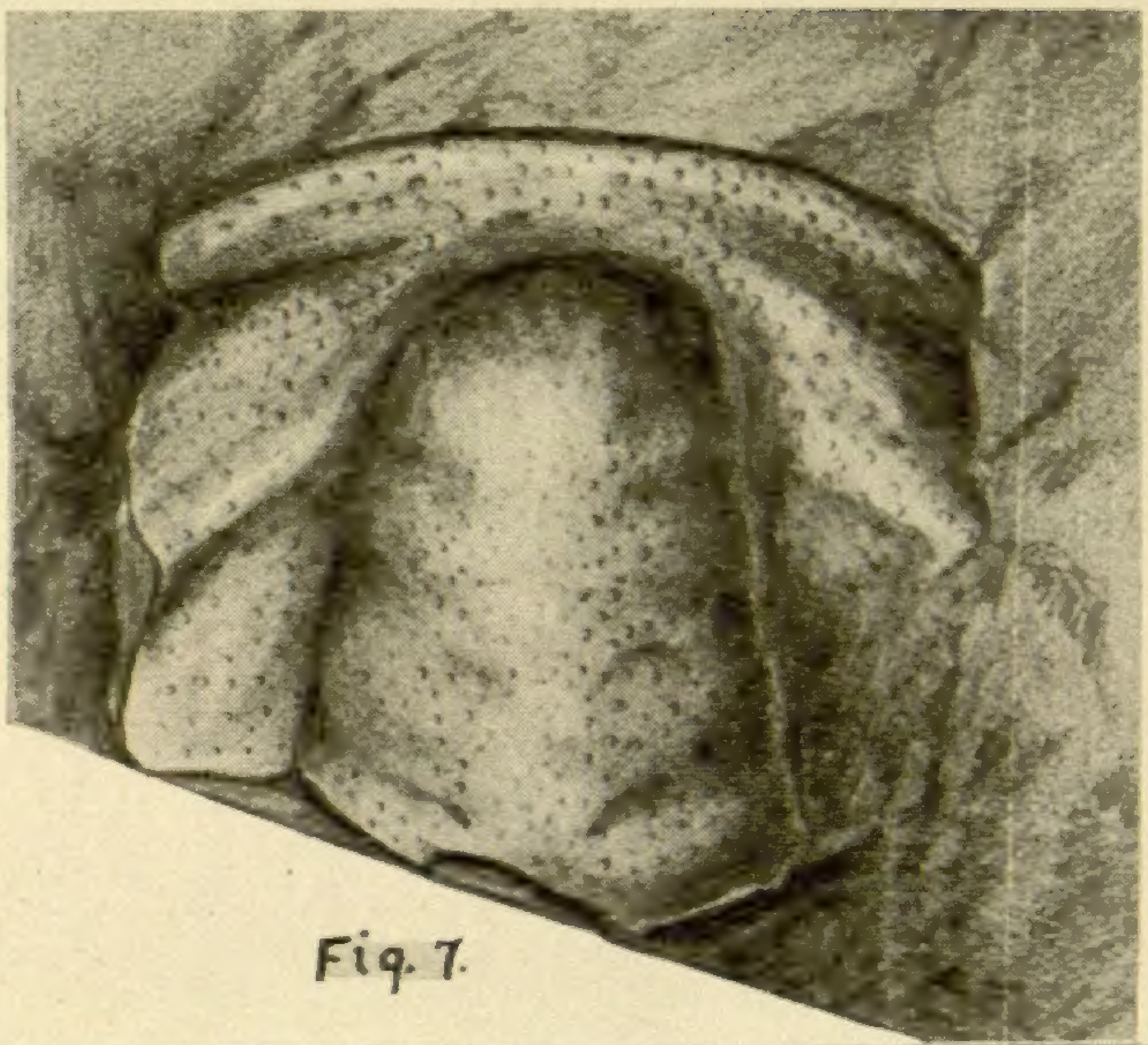

Fig. 7.

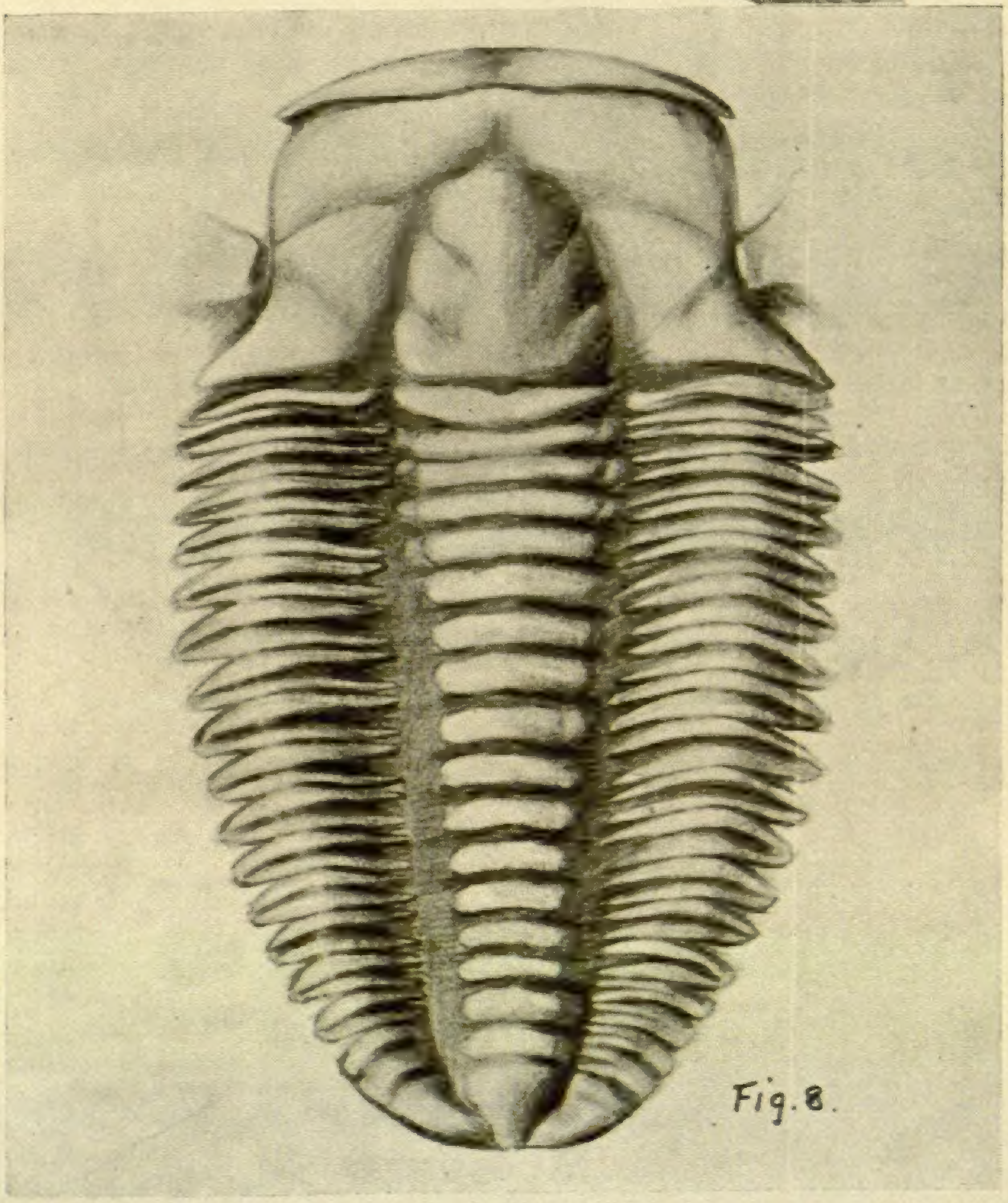

Fig. 8.

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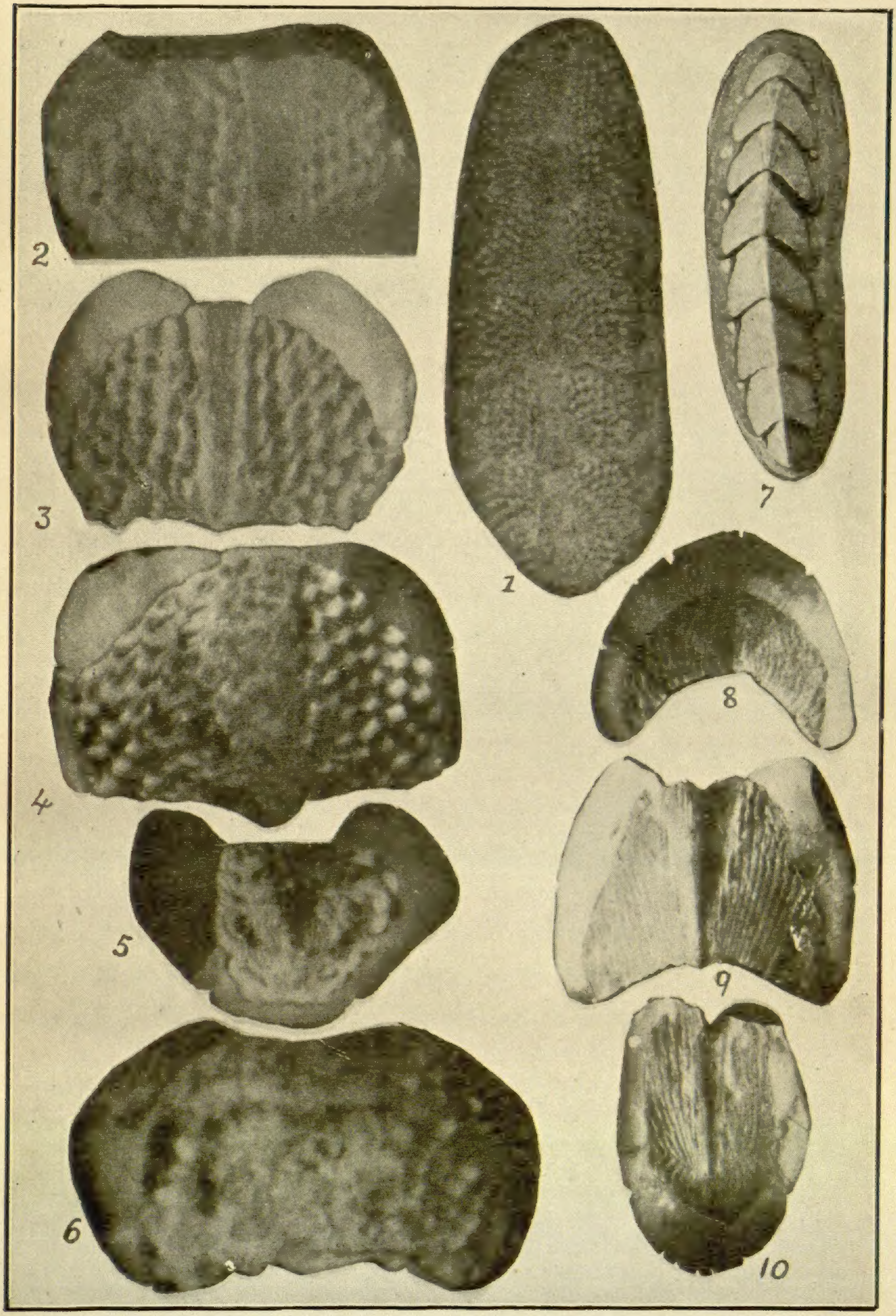

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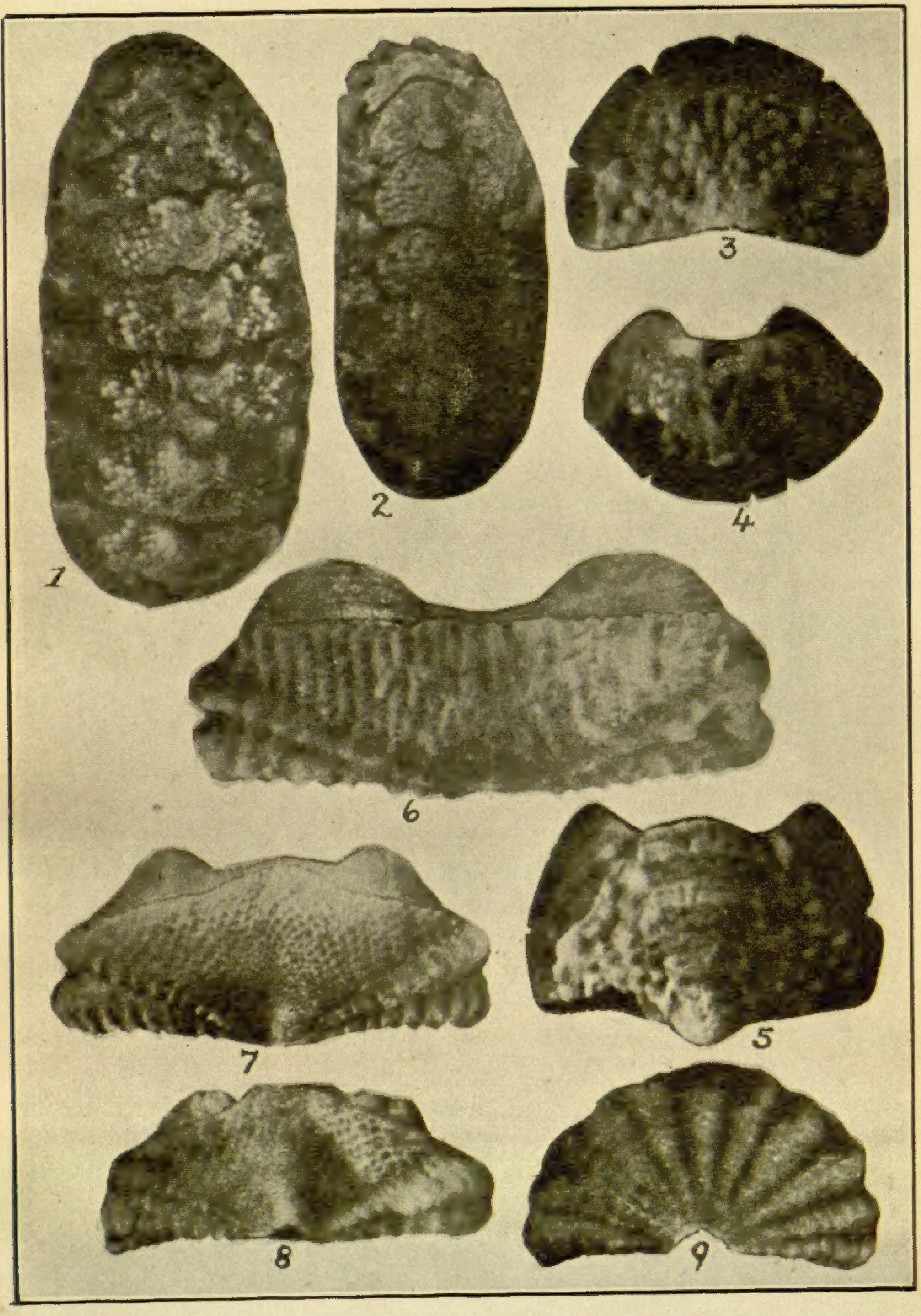

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